Speed

Freak

VECTORBEAM

OPERATION and MAINTENANCE MANUAL

Speed

Freak

PROPRIETARY NOTICE

The contents of this manual are the property of Vectorbeam and are not to be copied or reproduced in any manner whatsoever, nor disseminated in any form to any person who is not a Vectorbeam user without the permission of Vectorbeam.

TABLE
OF
CONTENTS

4 MAINTENANCE

5 ILLUSTRATED PARTS BREAKDOWN

LIST OF APPENDICES

APPENDIX A
Reference Schematics

LIST OF ILLUSTRATIONS

LIST OF TABLES

Game
Set Up 1

ENTERING
VECTORREAM
COUNTRY
WATCH FOR
'SPEED FREAK'

GENERAL

This chapter describes your Vectorbeam Speed Freak game, the selected location for your game, and how to inspect it. It also outlines the preliminary set-up procedure.

The Vectorbeam Speed Freak game is a colorfully illustrated upright video game which appropriately justifies the vector display technology creating the illusion of a three dimensional roadway filled with exciting obstacles such as opposing vehicles, roadside objects and much more.

The Speed Freak game is a single player first-person driving game with the front-end of the player's vehicle displayed onto a curving roadway which disappears into a vanishing point. As the player depresses the accelerator pedal, the vehicle heads toward cactus, hitchhikers, bridges, flying airplanes and other objects as they begin to appear faster and faster as the player increases his vehicle speed. The object is for the player to avoid the objects on or off the road with a speed as fast as his skill allows. A more detailed game play is located in the Game Description chapter of this manual.

The major components of your Speed Freak game are illustrated in Figure 1-1. These major components are the following:

- coin mechanism
- vector monitor chassis
- power supply chassis
- control panel
- accelerator pedal
- all PCB assemblies

The PCB assemblies of the Speed Freak game are contained in the game cabinet. These components are listed in the following:

- Game logic PCB
- Vector TV monitor PCB
- Audio PCB
- Steering PCB
- Shifter PCB
- PROM PCB (temporary)

CONTROL PANEL

POWER SUPPLY CHASSIS

ACCELERATOR PEDAL

PCB ASSEMBLIES

COIN MECHANISM
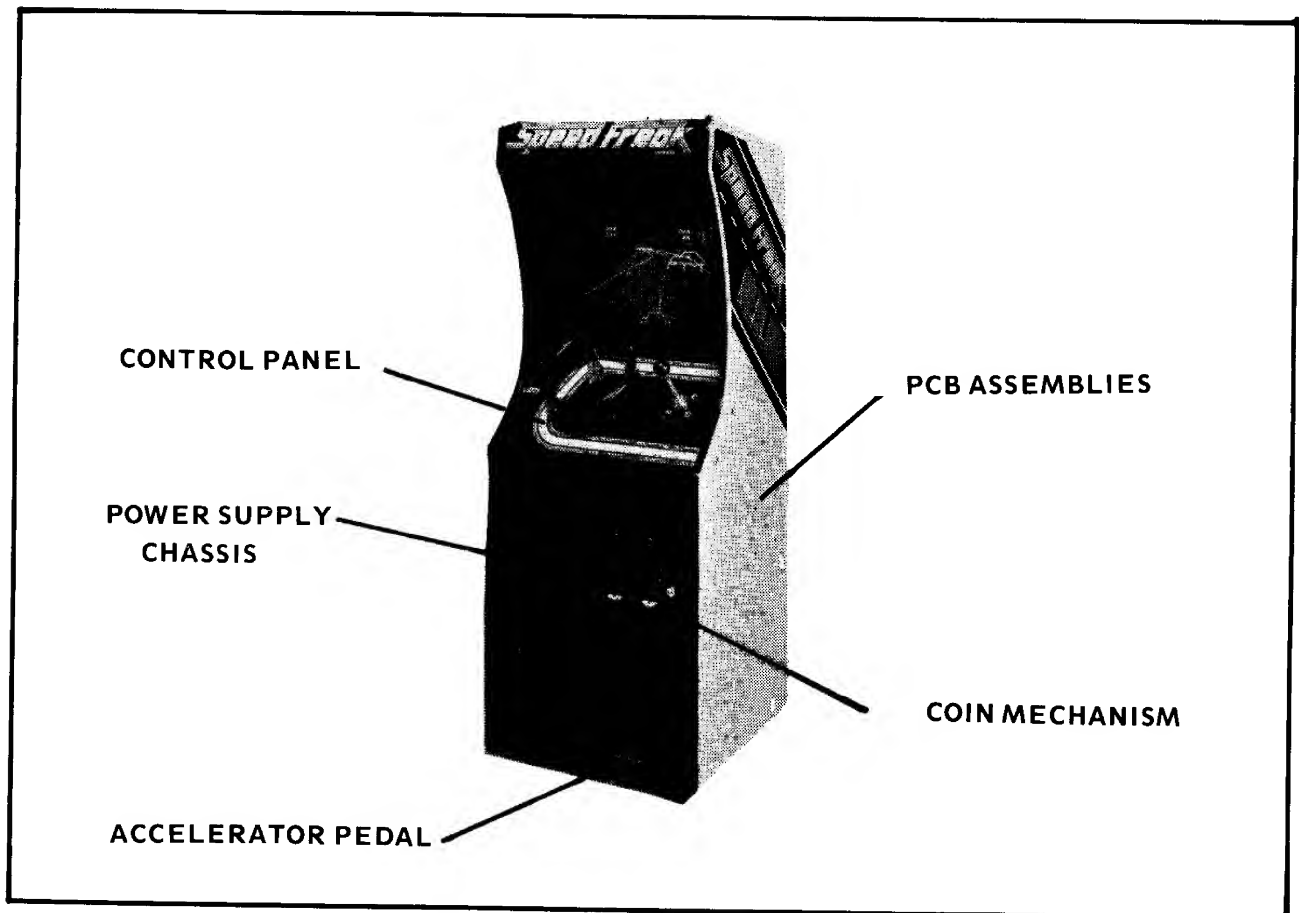
Figure 1-1 Vectorbeam Speed Freak Game
Major Component Locations

The operator control panel, as illustrated in Figure 1-2 is comprised of the four-speed gear shifter, the steering wheel and the start button.

INSPECTION

All Vectorbeam equipment is carefully packaged in well padded cardboard containers to prevent damage during shipment. If a component is noticeably damaged, notify the Vectorbeam Customer Service department for information concerning the disposition of the damaged component. To avoid cancellation of the warranty, DO NOT apply power to the game.

NOTE

For kit information refer to Appendix B.
(Supplement to be mailed later.)

To ensure that the equipment has suffered no damage in shipment inspect the container prior to acceptance from the carrier. If no immediate cabinet damage is evident perform the following visual inspection.

(a) Remove the rear access panel with the appropriate packaged key (refer to Figure 1-3).
(b) Examine each major and electrical component thoroughly for scrapes, dents, broken or missing parts and loose or missing screws.
(c) Check for loose cable connectors.
(d) Visually verify that all the integrated circuit devices (IC's) plugged into sockets are properly seated and that no IC pins are bent or misaligned.

Should any damage be discovered during the foregoing inspection, a claim should be filed with the carrier. A complete report of the damage should be forwarded to Vectorbeam.

STEERING WHEEL

GEAR SHIFTER
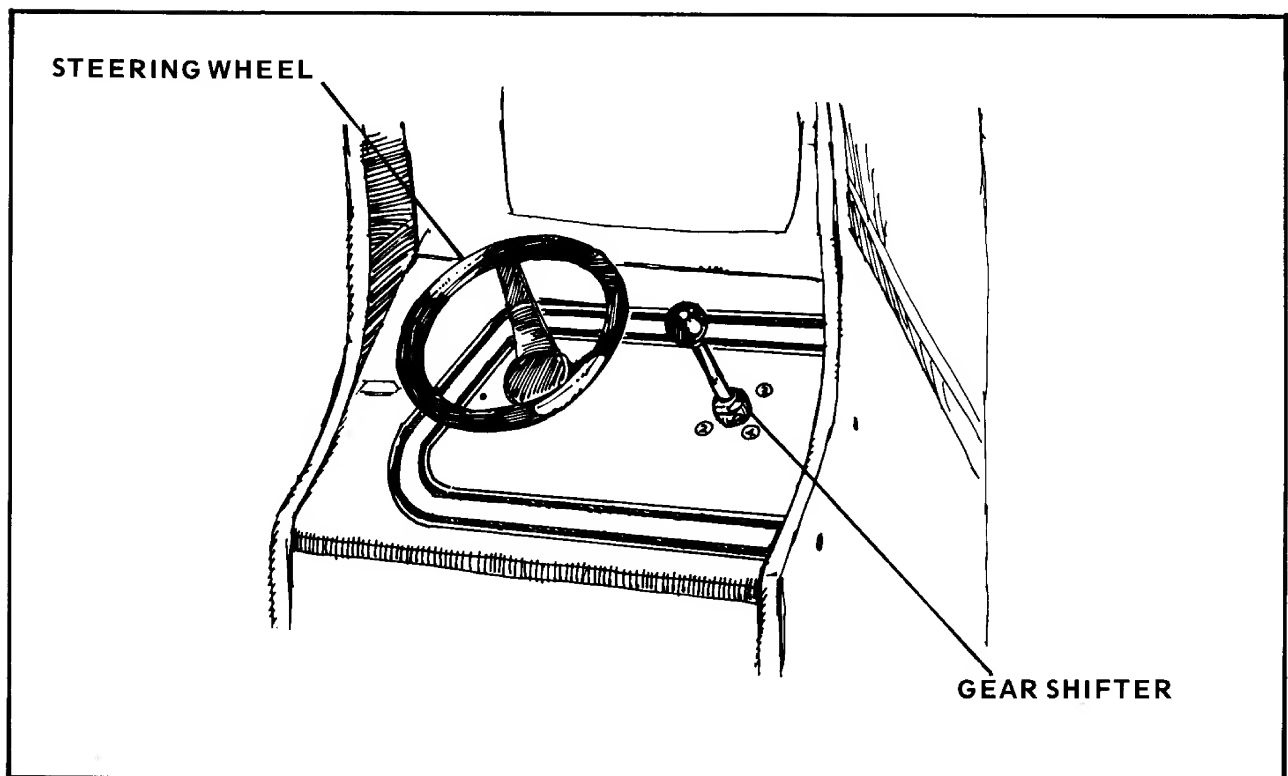
Figure 1-2 Speed Freak Control Panel
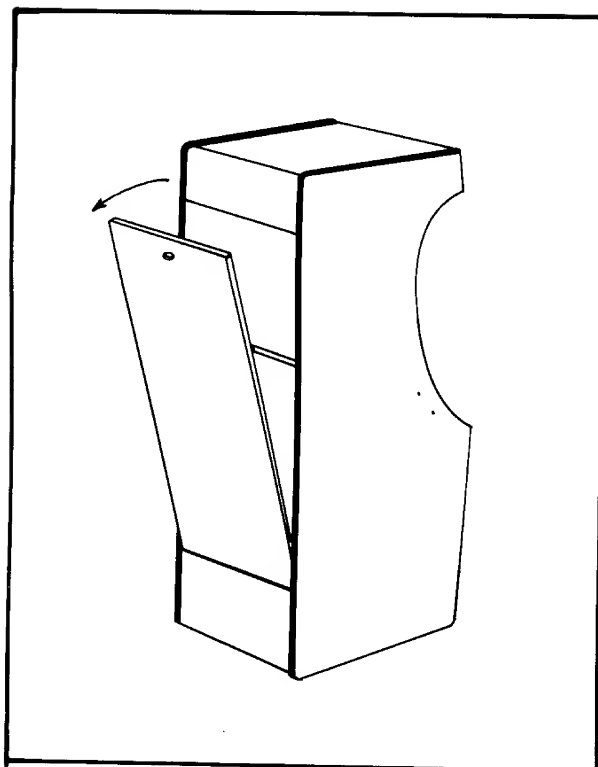
Figure 1-3 Rear Access Panel

INSTALLATION

Planning the location of the game should involve both physical and electrical consideration. Physical considerations concern the placement of the equipment with respect to clearances, AC cable and environmental conditions such as ventilation, temperature, weight support and accessibility (although your game has the durability to endure nearly every type of physical hazard). Electrical considerations include availability of the correct voltage and frequency.

In planning this installation, consideration must also be given to working space required for personnel involved with operation or maintenance of this system.

NOTE

The cabinet must be within five feet of an AC outlet. Be certain that a ground jack or terminal is available at the outlet.

CAUTION

Warranty void when the AC ground prong is broken off the plug.

AC Line Voltage Selection

AC line voltage selection is available in your Speed Freak game by setting the appropriate jumpers on the power supply chassis.

Table 1-2 lists the selectable jumpers for either 100 VAC, 115 VAC or 230 VAC. Always check for the correct AC line voltage with an AC voltmeter at the AC outlet.

TABLE 1-2
AC Line Voltage Selection

Input Voltage	Jumper Terminal	Input Connection
100 VAC	1 to 2, 3 to 4	1 and 5
115 VAC	1 to 2, 3 to 4	1 and 4
230 VAC	2 to 3	1 and 4

PRELIMINARY CHECKOUT PROCEDURE

The Speed Freak game, after it is properly installed, should be checked operationally by performing the following procedures:

(a) Plug in the AC jack into the AC outlet.
(b) Allow 1 to 2 minutes for CRT warm-up.
(c) Observe the TV monitor display to assure the correct Attract mode is present on the screen (the Attract Attract mode is explained in detail in the Game Description chapter).
(d) If the Speed Freak Attract mode display is incorrect, refer to the Maintenance chapter.
(e) Insert quarter into either slot of the coin mechanism. Attract mode should disappear and the game should be in the Ready-to-Play mode as described in the Game Description chapter.
(f) Proceed to play the game and verify that all screen images are displayed as shown in the illustrations of the Game Description chapter.

If adjustments are necessary refer to the Maintenance chapter.

INTERLOCK SWITCH CHECKOUT PROCEDURE

The interlock switch (Figure 1-4) has been provided by Vectorbeam to effectively secure a safeguard for the maintenance technician, while working inside the cabinet. This interlock switch should be checked for precautionary purposes by performing the following procedures while power is supplied.

(a) Unlock the rear access door but do not remove it.
(b) Slowly pull the upper half of the rear access door until the CRT filament (see Figure 1-5) indicates the absence of AC line power.
(c) If the CRT filament of Step 8 is not lighted check the fuse on the power supply, the interlock switch and power cables.
(d) Close the rear access door, wait a couple of minutes and the monitor should display in the Attract mode.
(e) Lock the rear access door and reposition the cabinet to its permanent position.

The AC power to the game may be applied when the rear access door is removed by pulling out the interlock plunger, illustrated in Figure 1-4.
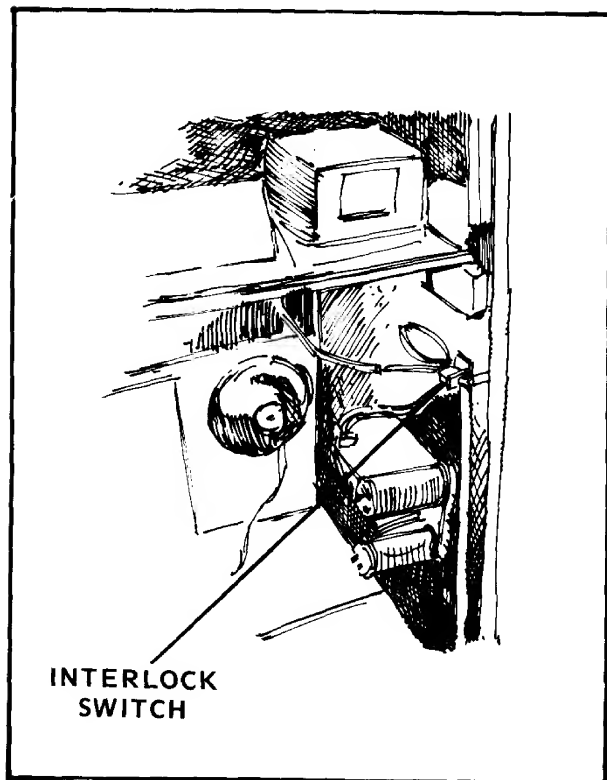
Figure 1-4 Interlock Switch Location
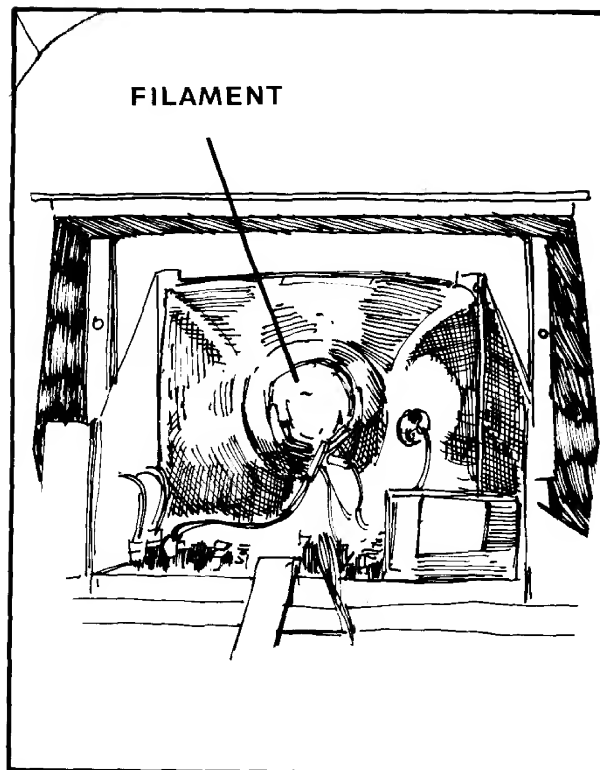
Figure 1-5 CRT Filament Location

Operator Option Switch

The operator option switch is a two toggle DIP device located on the logic PCB. The photo of Figure 4-9 indicates the exact location. The DIP toggle settings are illustrated in Figure 1-6.

A double coin jumper option is available to the operator. It is located on the audio PCB.

Extra time is 3/8 of the game time.

GAME TIME PER COIN

60 sec	90 sec	120 sec	150 sec
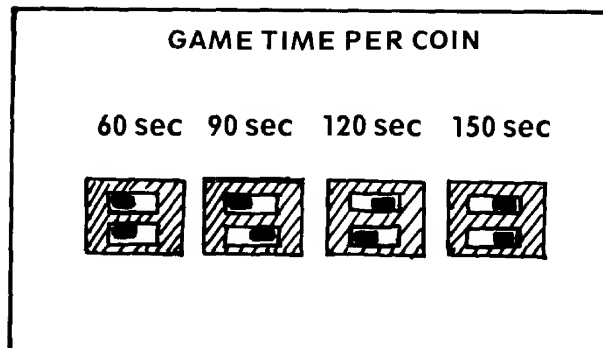
Figure 1-6 Operator Option Switch Settings

2

LANCE FEB 79
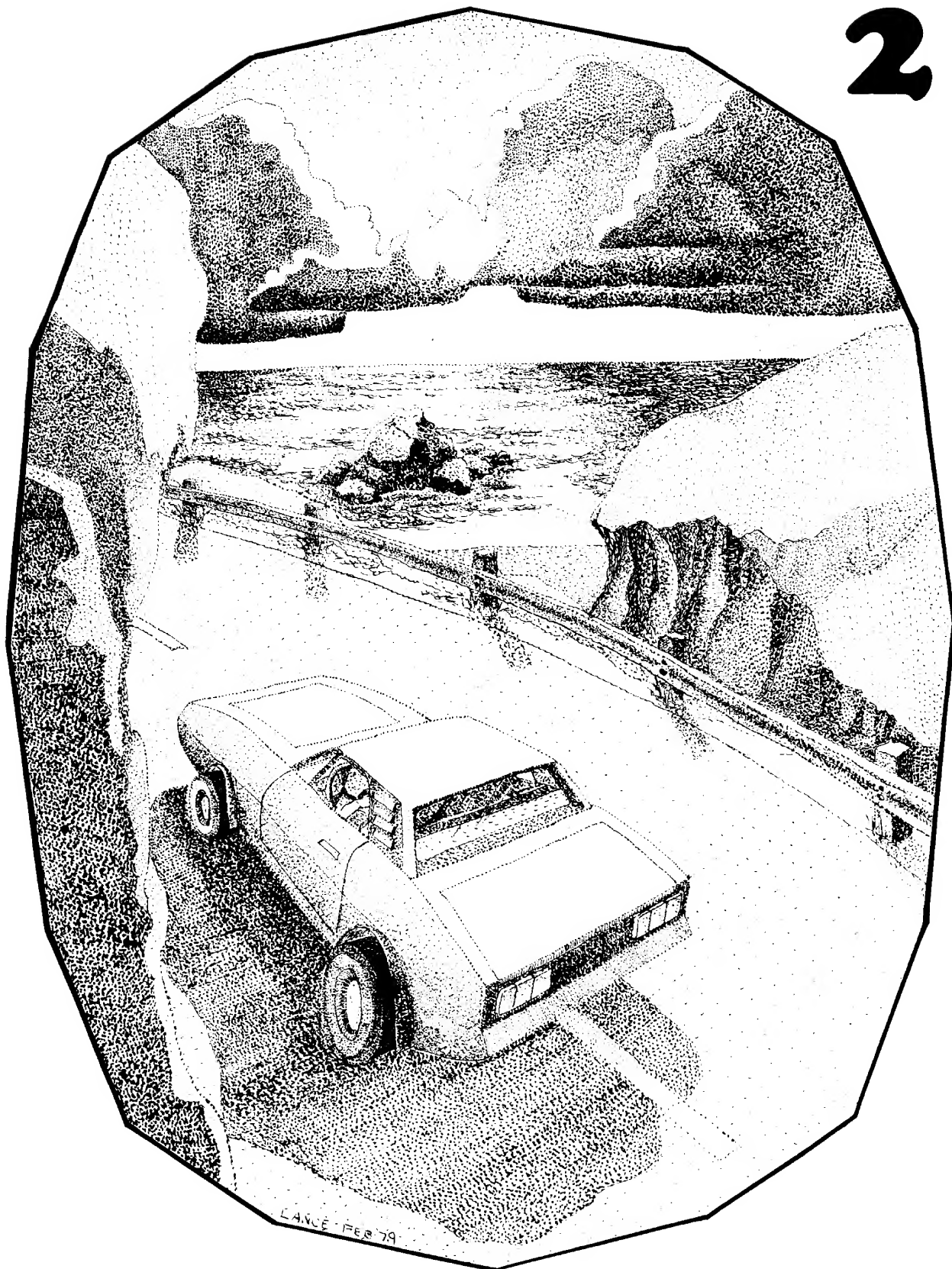
Game Description

GENERAL

The Vectorbeam Speed Freak game has all of the controls a player needs to feel totally in control of his own vehicle on a country roadway. The three dimensional visual effects are only a portion of this game's realism. The exciting audio simulates the sound of a racing car, the shifting of gears and screeching tires on pavement as the vehicle skids off the road or while swerving out of the way of a road obstacle.

The following paragraphs explain the different game modes needed to be checked after either set-up or repair to ensure that it is operating properly.

Attract Mode

Figure 2-1

The Attract mode appears on the TV monitor screen 1 to 2 minutes after the AC power is applied. The Attract mode consists of a three dimensional two lane straightaway more or less center screen. The front portion of the player's vehicle appears at mid-lower screen which creates the first person ffect. This vehicle is superimposed on to the right

lane as it speeds down the roadway. An occasional road sign, cow, bridge or hitchhiker is passed by the unattended vehicle.

The 3 digit high score is displayed in the upper right hand corner of the screen and the current score is presented in the upper left hand corner. The high score is zero when AC power is initially applied, otherwise the high score displays the last highest score. This high score is reset each time power is removed then reapplied. The player controls remain inactive and the LED pushbutton switch is dark

Ready-to-Play Mode

Figure 2-2

The game is set into the Ready-to-Play mode immediately after the coin or coins are inserted. When the coin switch is activated by the coin the game is set into the Ready-to-Play mode.

The TV screen displays the attract mode images plus the extended play options approximately mid-upper screen. The controls remain inactive while the LED pushbutton switch is flashing.

Figure 2-1 Attract Mode Screen Display
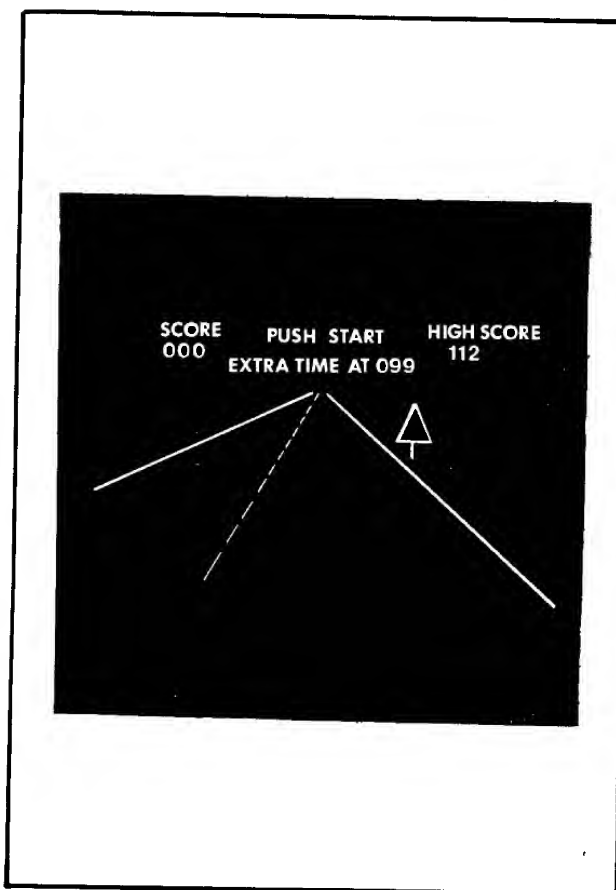
Figure 2-2 Ready-to-Play Mode Screen Display

Play Mode

Figure 2-3

The play mode is triggered when the player presses the flash LED pushbutton located at the left hand side of the control panel. The TV screen instantly displays a curved roadway. The front portion of the player's vehicle remains motionless on the right hand until the accelerator pedal at the bottom of the game cabinet is depressed as illustrated in Figure 1-1.

As the player continues to depress the accelerator pedal, the vehicle begins to accelerate, while moving on the screen corresponding to the steering control. The shifter at the right hand side of the control panel should be in first gear (labled). The game simulates engine wind-out in each gear.

The player has complete control of his car as it races against the clock at a speed equal to his skill. The clock in the upper left hand corner counts off the player's driving time in seconds. The clock is set at the beginning of each game according to the switch option available only to the operator. The player can extend his time when reaching a score set at the operator option switch. The player's current score is displayed in the upper left hand corner. Each time the player reaches the extended time score, the words "EXTRA TIME" are flashed on the upper mid portion of the screen, as illustrated in Figure 2-4.

The clock continues to run, giving the player points until the car runs off the road or hits an obstacle. Each time an accident occurs the clock stops until the crash display terminates and resets the display to a normal game mode as illustrated in Figure 2-3.

Either of the two thrilling accident scenes are displayed on the screen. One crash scene appears every time the player's car skids off the road or hits an obstacle other than a police barricade or an on-coming car. The other scene appears whenever the on-coming car is hit or when the player's car rams the police barricade.

An audio warning of a possible accident is sounded by the screeching of tires or the horn of the opposing car when the player's car crosses into the left lane.
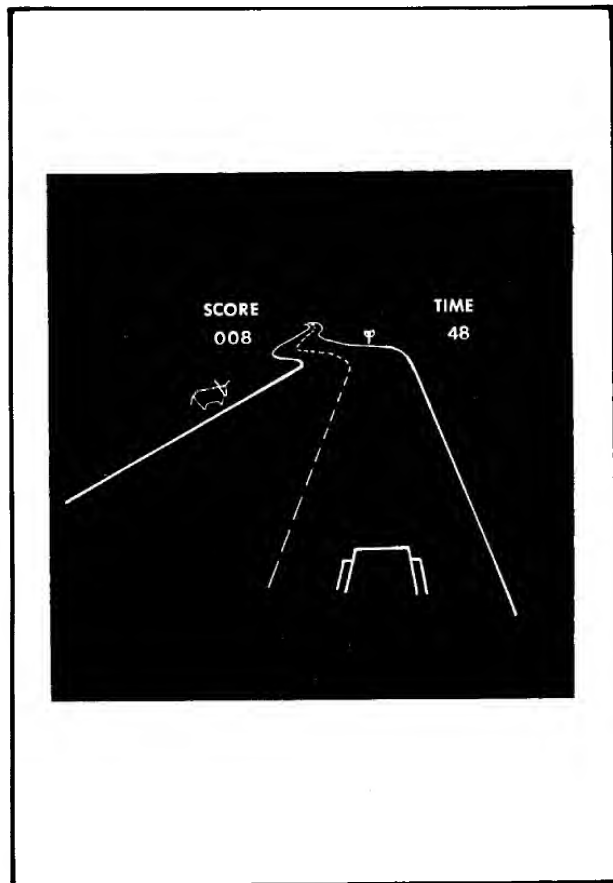
Figure 2-3 Play Mode Display
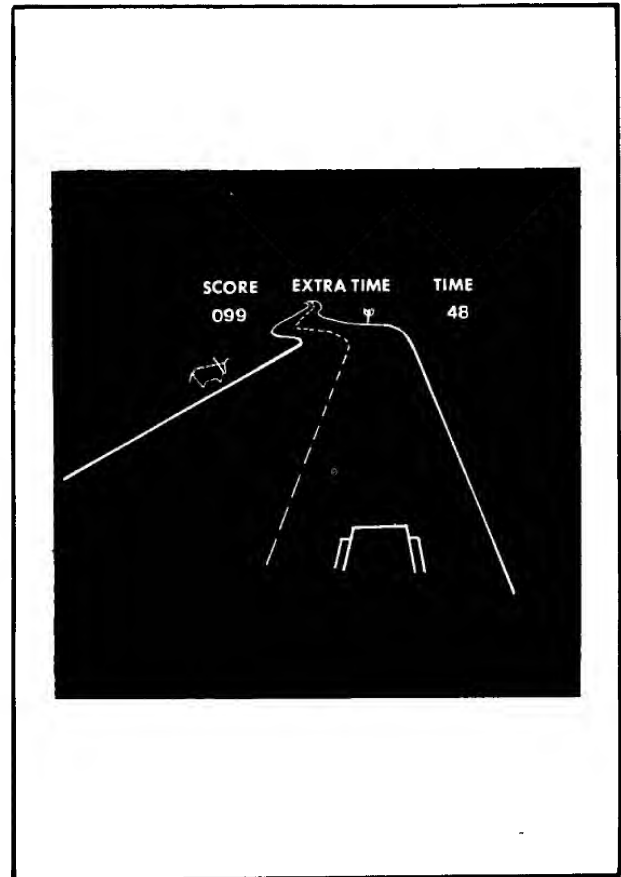
Figure 2-4 Extra Time Mode Display

2-3

THEORY
OF
OPERATION

3
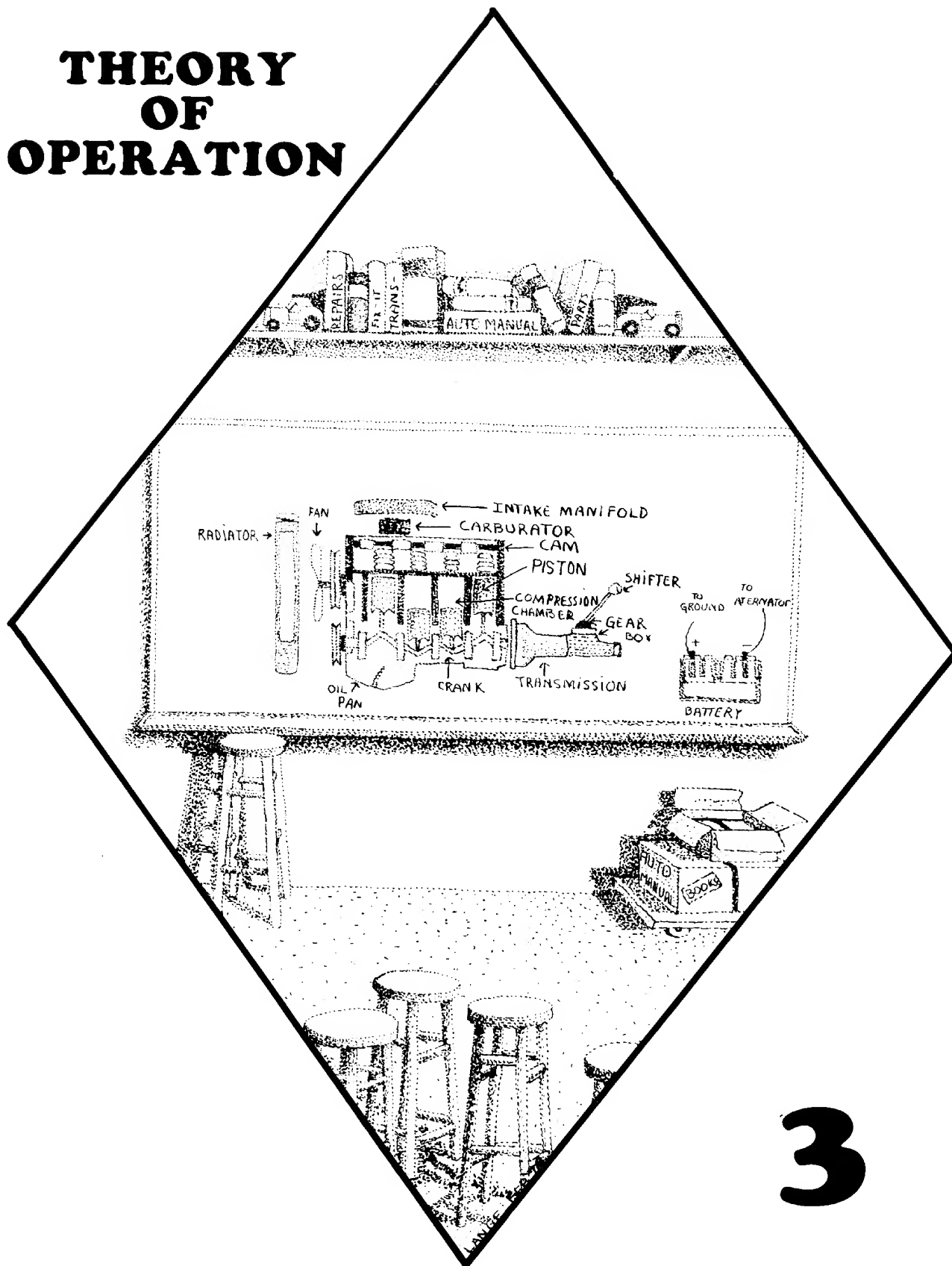
GENERAL

This chapter describes the principles of operation of the major circuit functions of the Vectorbeam Speed Freak Game. The system's general functional description is followed by detailed circuit descriptions. Each circuit description includes simplified circuit schematics (Appendix A) applicable to the blocks under discussion. Note that all of the schematics used are very similar to the schematics used by most industrial electronics firms. The use of the wide arrowhead paths simplify the schematic bus lines.

GENERAL DESCRIPTION

Figure 3-1 illustrates all of the major components of the Vectorbeam Speed Freak game. This block diagram indicates that the logic board is separate from the monitor. It also illustrates the low voltage power supply package, the coin mechanism, the control panel and how they are interconnected.

Figure 3-2 illustrates the logic board block diagram. The dash lines indicate what is used and shared by the monitor display electronics. It also indicates that which is to be only used by the display electronics on the monitor board.

MONITOR DISPLAY

(Refer to Appendix A, Figure A-1)

All monitor electronics are self-contained on a single printed circuit board. All low voltages supplied to this board originate from the power supply package located inside the game cabinet. All troubleshooting and maintenance procedures are located in the MAINTENANCE chapter of this manual.

The Vectorbeam monitor is unlike the conventional TV monitor. It is a vector system that displays vectors (lines) generated from X-Y coordinates received from the logic board. The horizontal points are X and the vertical Y (width and height respectively). The X and Y logic signals originate from the logic board, discussed later.

The ±25 volts and 6.3 volts AC and the +25 volt spot kill originate from the low voltage power supply. The ±25 volts is a DC voltage rectified and filtered in the supply package. The 6.3 volts AC is used as the heater voltage for the CRT display. On Figure A-1, in the upper-left hand corner, voltages have been regulated by the three terminal regulator devices. For example the ±25 volts is regulated by a 7818 and a 7918 respectively down to ±18 volts used by the oscillator. Transformer T1 provides the means to supply the CRT grid and anode voltages. The +25 volts is also regulated to +5 volts used for the logic circuitry included in this drawing. The circuit connected to the primary of T1 (a high voltage transformer) form an oscillator which induces the necessary high voltage at the secondary of T1. The frequency is set by the T1 transformer characteristics.

The output of the T1 is then rectified. The highest voltage winding is connected to the tripler M1 which raises the output voltage of this transformer and rectifies it to +18 K volts, for the CRT anode. At pin 6 the negative pulses are rectified and applied to a 1 megohm potentiometer FOCUS control which applies the grid bias at pin 4 of the CRT. The positive pulses are rectified at pin 7 of the T1 transformer as the grid 2 bias for the CRT whereas the CRT at pin 2 is at ground through register R108. The heater pins 1 and 8 of the CRT are connected to ground and pin 1 of the PCB respectively. The ±25 volts is also regulated down to ±15 volts for the DAC's by device U10 and U11 (7815 and 7915 respectively). The secondary of T1 (pins 5 and 8) develop the necessary voltage to produce a +90 volts DC rectified by diode CR50 and filtered by capacitor C28. This +90 volts DC is used by the modulating circuit for the CRT display.

The lower half of the drawing consists of the spot kill circuit and the intensity modulator circuit. The intensity modulating circuit is comprised of two individual circuits. One input is the high intensity and the other the normal intensity. These two inputs are connected to the high and normal intensity transistor drivers Q20 and Q21 and the hex inverter U6 (7406). Both circuits are identical.

For example, in this explanation the high intensity circuit is described: In the high intensity circuit when the input goes high at pin 1 of U6 the output at pin 2 goes low. With this low signal, Q20 is turned off from an on state, and the collector of Q20 goes high. Assume that switching transistor Q24 is turned on. The NORMAL INTENSITY input is always on when the display logic is operating properly. A low input at PCB connector (pin 12) is inverted by hex inverter 7406 which turns on transistor Q22. Device Q22 completes the current path through the intensity control (R91) to ground via resistors R78 and R79 and collector to emitter of Q22. This condition applies a voltage less than +90 volts corresponding to the setting of the intensity control, to the CRT cathode.

When a higher intensity is required the HIGH INTENSITY input (pin 14 of the Display PCB) goes low turning on Q20. With Q20 turned on the current path from the +90 volts line in through R91, diode CR39 then finally through the collector to emitter of Q20 to ground. This condition reduces the voltage at the wiper of R91, therefore increasing the intensity of the electron beam. The NORMAL INTENSITY input should always remain low providing some sort of constant electron beam.

When the —25 volts is removed, pin 9 of U6 goes high and pin 8 goes low, which immediately turns off Q14 eliminating the chance of a spot. The U6 device is an open collector evice requiring a pull up resistor such as R86 at pin 8. The high side R86 is connected to a voltage source at pin 3 of Molex connector J2. +25 volts unregulated and unfiltered.
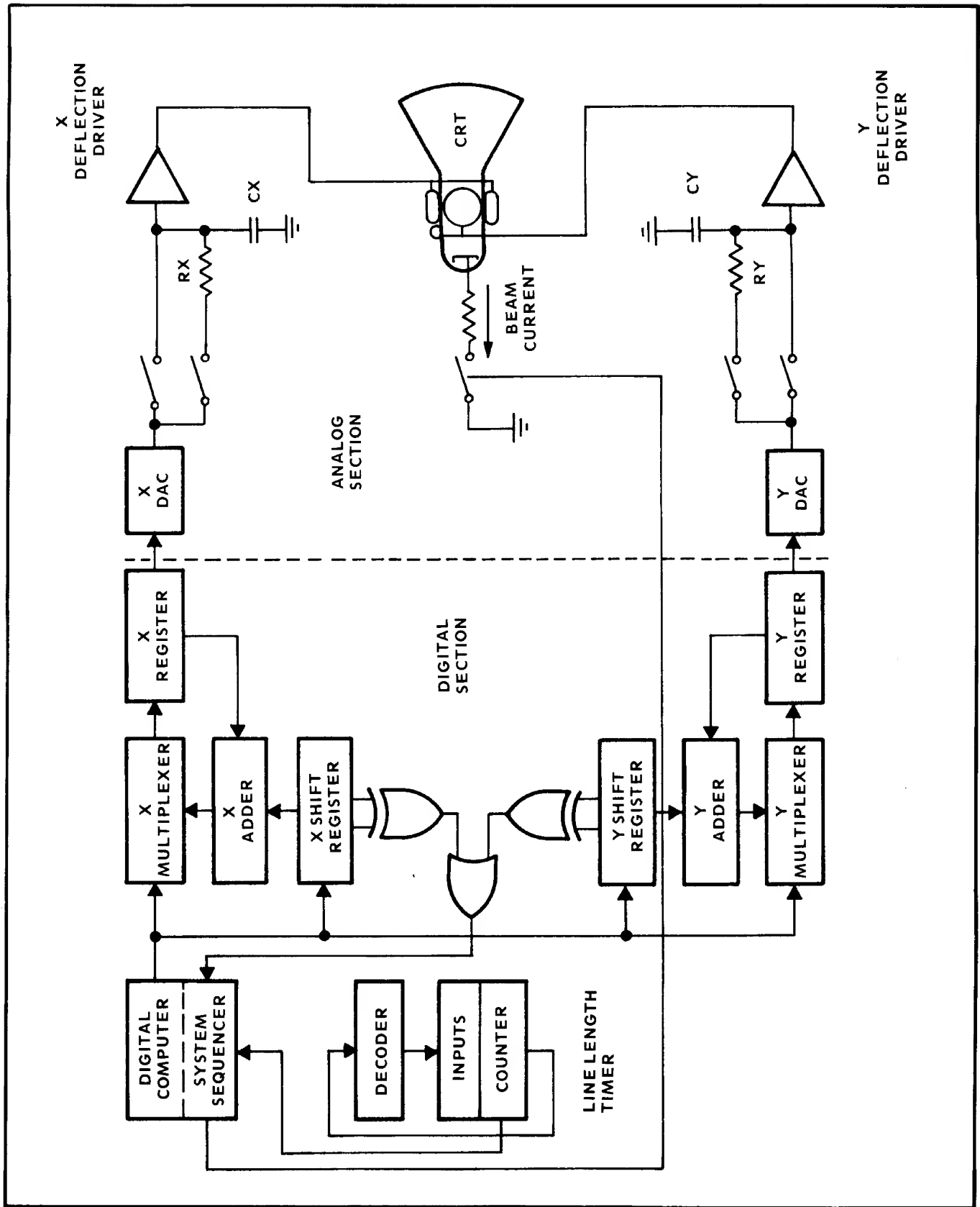
Figure 3-1   General Block Diagram of Speed Freak Game
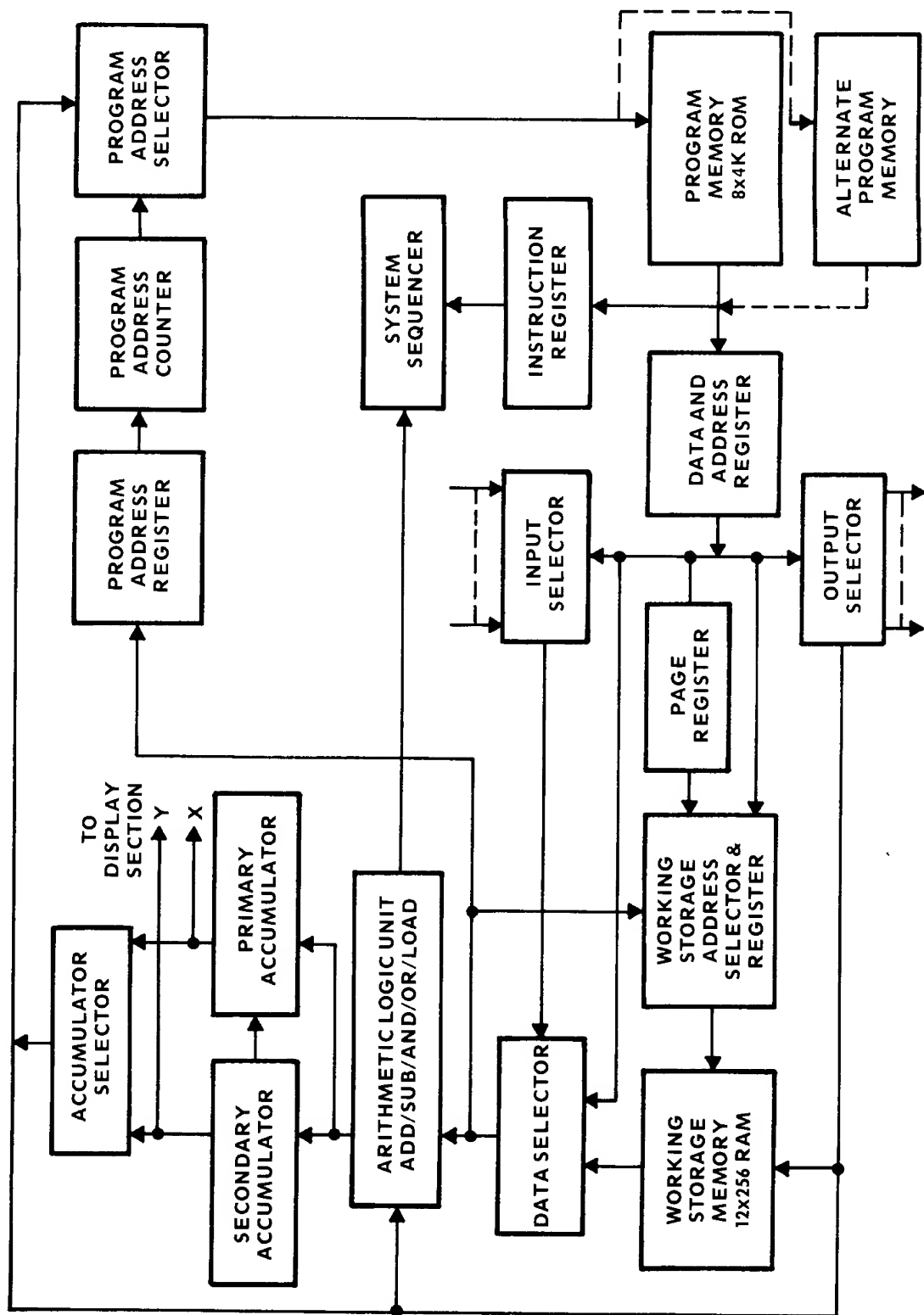
Figure 3-2   Block Diagram of Logic PCB

Another spot kill protection circuit (Q21, Q23 and U6) keeps Q14 on when either intensity input is high but when both inputs are low it provides a 2 millisecond turn-on time for Q14. After the 2 millisecond period the Q21 device turns on removing the current path through Q20 and Q22 by turning off Q14. This is accomplished when pins 2 and 4 of U6 are both high which turns on Q23, inverts at pin 10 of U6. Pin 10 of U6 as it switches from a low to a high is initially at ground, then gradually goes positive at C18, until after approximately 2 milliseconds it is positive enough to turn on Q14.

(Refer to Appendix A, Figure A-2)

The schematic of Figure A-2 illustrates two identical circuits, one for the Y and the other for the X coordinate. For purposes of this explanation only the upper half will be discussed (the Y coordinant circuit of Figure 3.4). Beginning with the inputs we have 12, 6 inputs to DAC U5 defining the Y coordinate. These DAC's generate approximately 4096 (4K) different positions on the screen for the Y coordinate, likewise 4096 for the X coordinate at the lower half of the circuit. Supply voltage to these two DAC's (U6 and U1) originates from the +15 volt regulators of Figure A1 (U10 and U11). The analog output of DAC U5 enters the non-inverting input of amplifier U4 from either the analog Switch 1 or th analog Switch 2. Assume that 4 volts at the analog output (pin 15 of U5) and that analog Switch 2 has been enabled. The 4 volts applied to the input OP-AMP U4 also appears across capicitor C35. The output voltage at the circuit of U4 also appears at the wiper of potentiometer R54. The voltage at this wiper is applied to a discrete differential amplifier circuit comprised of device Q16, Q17 and Q18. The +4 volts turns on Q17 which also turns on transistor Q8. The input to this transistor is the output of the differential amplifier of Q17 and Q18. This output is then urrent boosted by the Q10 and Q110 devices for the positive transistion or by the Q6 and Q111 for the negative transitions. Devices Q9 and Q12 are the overload protection. The current then flows through the Y (vertical) deflection coil and back to the inverting input at the base of Q18 in the differential amplifier circuit which nulls out, providing a perfectly balanced current injection circuit. Nothing is displayed on the screen since there is no signal entering the normal or high intensity inputs of the modulator circuitry of Figure A-1. Switch 2 opens leaving the charged capacitor C35 with the initial voltage, which is the initial point of the line segment to be displayed on the CRT after Switch 2 is opened (Switch 1 also remains open). The terminal point of the line segment is entered into the Y register of the logic board and then loaded into the DAC. Assume 5 volts at the output of the DAC, Switch 1 is energized, making contact and appling the 5 volt output from the DAC to the non-inverting input of U4. This new

voltage is across the RC network comprised of R58, R59 and C35. The modulating circuits of sheet 1 of 2 turns on the electron beam current to the CRT providing a display from the initial point (voltage across C35) to the terminal point, voltage which has been loaded into the DAC from the Y register. The transition from the initial point to the terminal point appears as a straight line. The rate at which this line segment travels is determined by the RC network at the input of U4. When the register is changed to a new point, Switch 1 opens and Switch 2 closes which places the new value across C35. The initial voltage across C35 is never displayed on the CRT until a signal at the intensity modulator input turns on the electron beam current to the CRT. The lower half of this section for the X coordinate is identical.

THE VECTOR GENERATOR

The vector generator is the digital section of the vector display electronics located on the logic board. As illustrated in Figure 3-3, it shows the working storage register, program memory, arithmetic logic unit (ALU), the primary and secondary accumulators together with the accumulator selector and the system sequencer logic. The remaining logic circuitry which is the X and Y register and the line length timer are primarily used for the display functions and are not shared with the game logic.

Figure 3-4 extracts the digital display electronics from Figure 3-3 simplifying its explanation. The line length timer included in Figure 3-4 is divided into the decoderand counter of Figure 3-5. The purpose of the line length timer is to determine the duration of closure to the electron beam switch which allows a vector to be displayed on the CRT.

The 12-bit presetable counter comprised of D6 and C6 is initially cleared (CLR) which sets it to zero. It then counts at the rate of the clock (CLK 8). The output of the counter addresses the preset decoder which produces outputs to the counter which are the preset inputs to the counter whenever a load signal goes low. This enable is removed when the line length counter reaches a maximum count.

THE GAME LOGIC
Program Memory

A PROM PCB is temporarily used in place of the standard ROM devices (8, 8 X 1K EPROMS). This PCB is remote from the logic PCB mounted next to the audio PCB. When ROM's (permanent devices) are developed they are to be installed in their appropriate sockets and remove the PROM PCB.
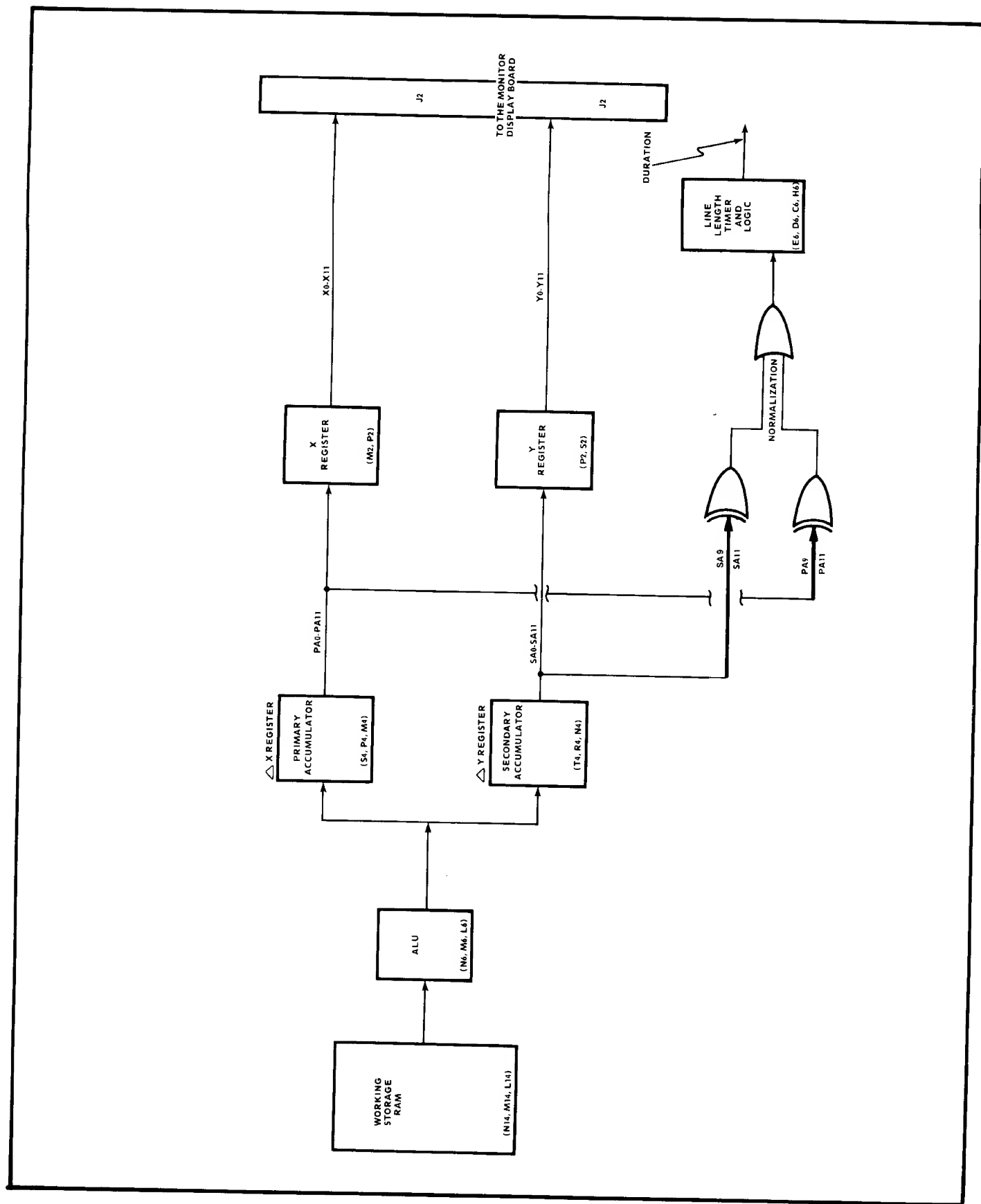
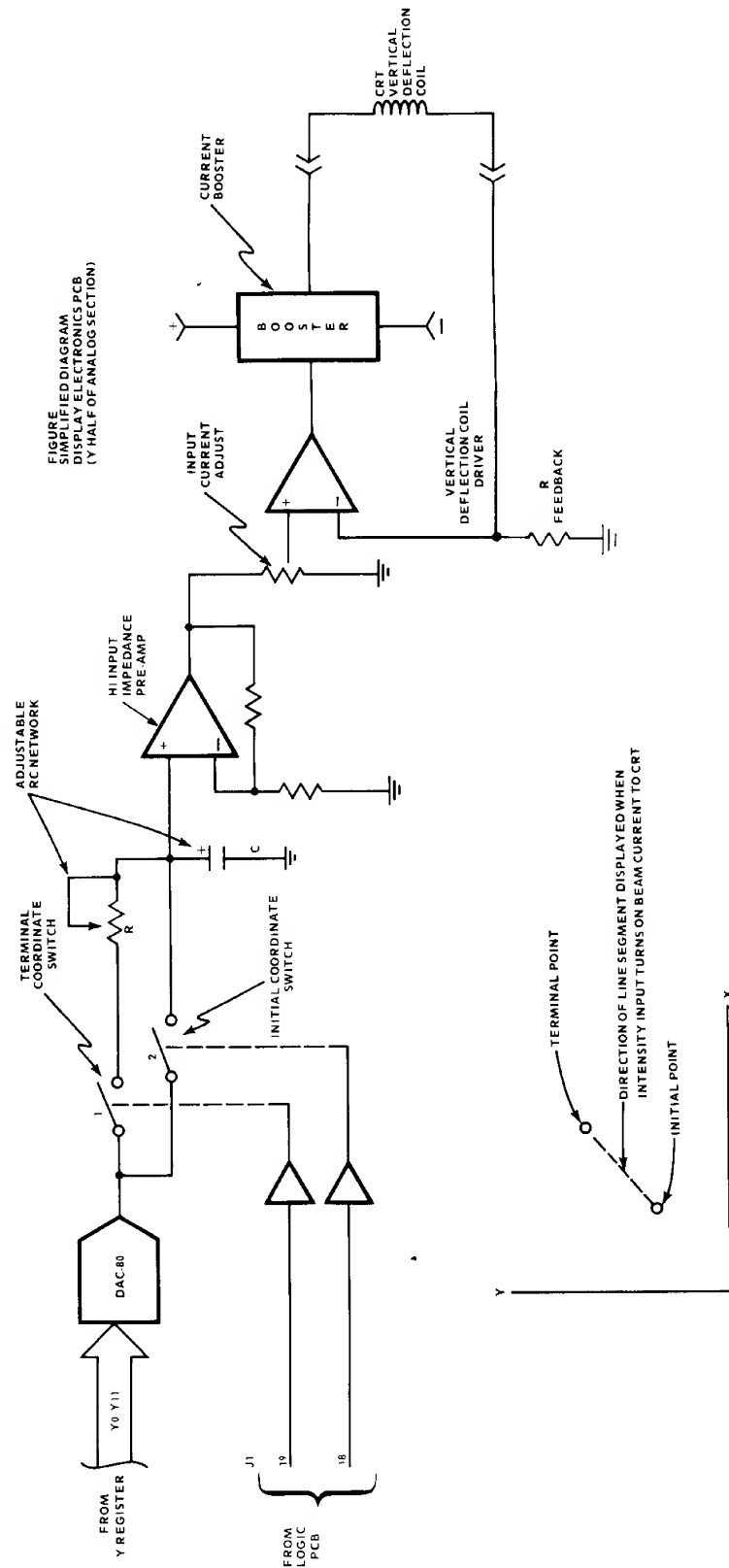Figure 3-3 Vector Generator Block Diagram

Figure 3-4 Simplified Block Diagram of
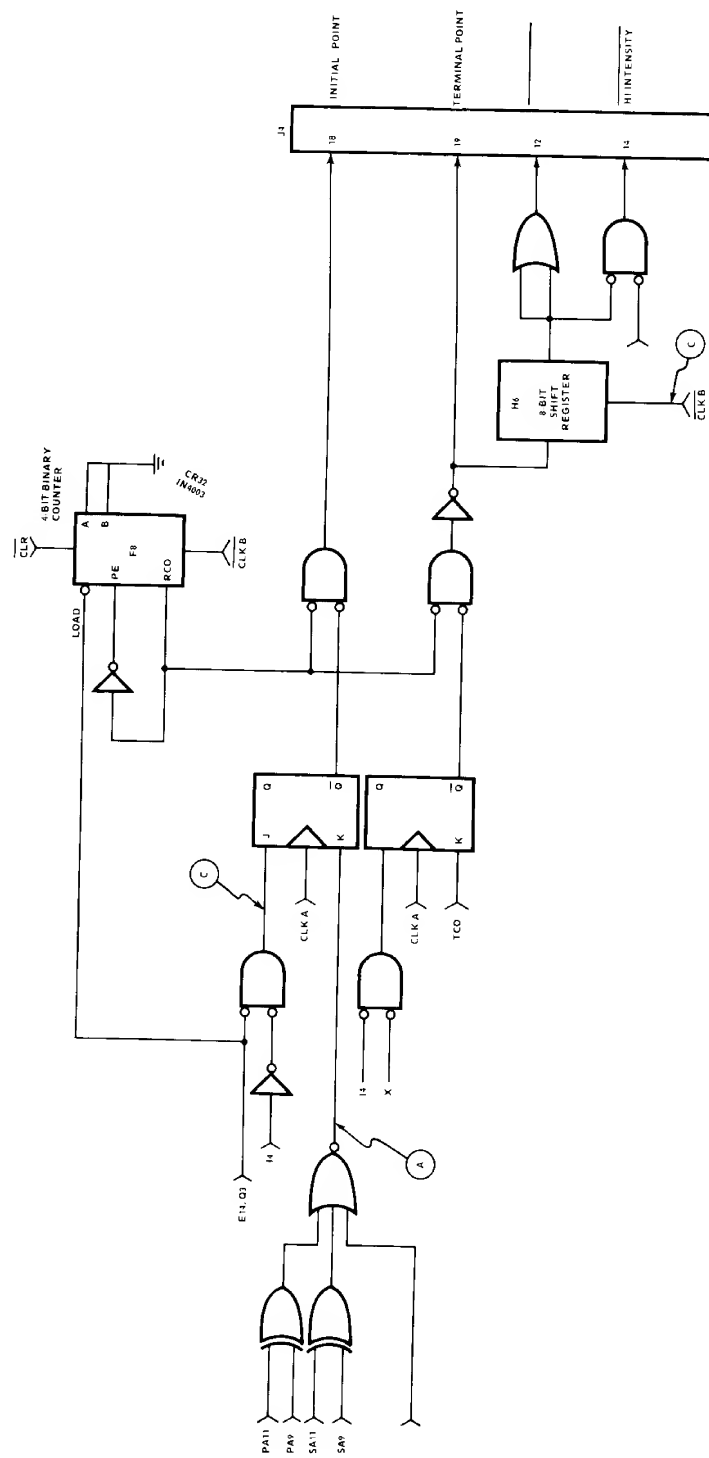The Display Electronics PCB
(one-half analog section)

Figure 3-5 Simplified Block Diagram of The
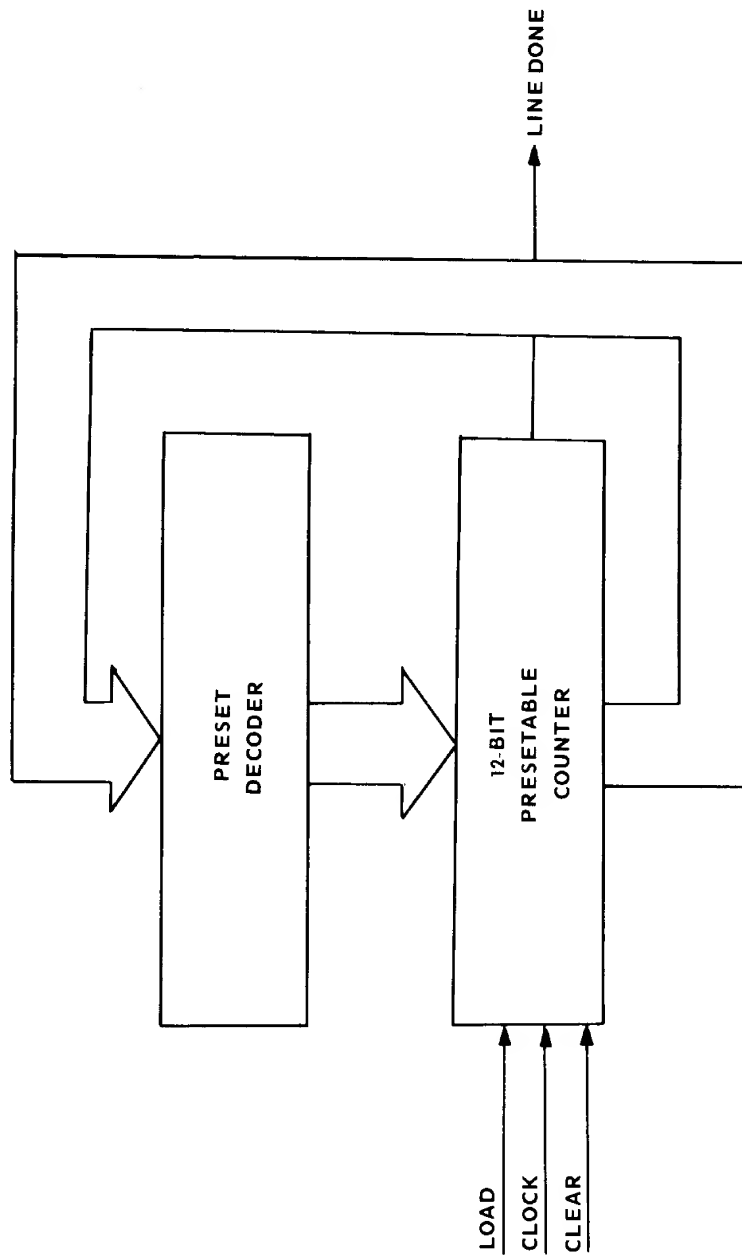System Sequencer Display Section

Figure 3-6   Simplified Block Diagram of
The Line Length Timer

The program memory is comprised of 2, 8 X 4K ROMS with two pages of memory in each: 1 even chip, 1 odd chip. The odd chip contains the odd memory and the even chip contains the even memory locations.

The Program Address Counter

(Refer to Appendix A, Figure A-5)

The program address counter is comprised of 4-bit binary counters S11, R11 and P11 (74LS163). These counters are presetable by the states of inputs at pin 3, 4, 5 and 6. The preset inputs originate from register devices P13 and R13 (74S377 and 74LS194 dual latch registers). These registers are loaded with the data from the output of the data selector (L0-L11) which originates from either the RAM or the ROM memory (see Figure A-6). When the register is loaded, the output presets the input to the program address counters. This preset input is loaded when pin 9 of each of the counter devices goes low. This preset input is the initial point from where the counters begin to count. The output of the program address counter, a sequential scheme, addresses the ROM program memory whenever the program address selector selects bus B. When A is selected it automatically is tied through the address bus to the ROM program memory. These counters carry output of each device (S11 the least signigicant device and P11 the most significant). The carry output of S11 triggers the R11 counter. Counter R11 reaches the count of 16 producing high carry output as a dignal t pin 10 to P11. This program address counter is capable of addressing all 4K words of memory in the ROM program memory.

Program Memory Data Bus Multiplexing

(Refer to Appendix A, Figure A-6)

The purpose of multiplexing the data bus from the program memory is to make 400NS chips look like 200NS chips. The data selector is comprised of devices T11 and U11 which are 2 to 1 data selector devices. When the A input to these two devices are selected it is the data currently processed at the output of the ROM program memory. When B is selected it is a delayed data structure. The outputs of these two data selector devices T11 and U11 form one data bus. The A or the B inputs to these data selectors are selected by the conditions of the outputs RESET, ODD and EVEN from devices U4. In this particular memory therefore the selection between inputs A and B means either the selection of the data from U7 (even) or from R7 (odd).

The Instruction Register

(Refer to Appendix A, Figure A-7)

The instruction register (T13) provides all of the instructions in nibbles (4-bits of an 8-bit word) to the system sequencer logic. These instructions are actual instructions

required to systematically set up the game with all the actual event sequences for the board logic.

The Data Register

(Refer to Appendix A, Figure A-7)

The data address register (S13) provides the data from the program memory multiplexed to either the RAM memory or RAM address, the computation circuitry or the program address counter through the accumulator D0-D3 is used by the RAM working storage memory and all 8-bits are used by the computation circuitry. The instruction data line I1-I7 is multiplexed by device G14 (74LS158).

Working Storage, Address Selector and Register

(Refer to Appendix A, Figure A-8)

The working storage address selector and register circuitry, provide the RAM address A0-A7. These address bits locate a particular memory address to either ''write'' into or ''read'' out of the RAM. This circuit is comprised of register H12, and single 4-bit register and registers J12 and I12, dual selectable 4-bit registers. Register H12, the page register, matches data bits D0-D3 to the output of H12 (QA-QD). Data bits D0-D3 and the delayed data bits D0-D3 are the upper A, B, C and D inputs to devices J12 and I12. The lower A, B, C and D to J12 and I12 are the W0-W7 RAM outputs. These outputs are divided down into nibbles whereas the J12 A, B, C and D lower inputs are W4-W7 and the lower A, B, C and D inputs to R12 of W0-W3. These two quad 4-bit registers as selectable devices, therefore either the RAM output data or data register bits are selectable by the state of the select bit of pin 10, to address a given location in RAM memory.

The Data Selector

(Refer to Appendix A, Figure A-8)

The data selector circuitry is comprised of N11, M11 and L11 (74LS157). The purpose of this circuitry is to select either the data register data bits which are at the inputs of the computational circuitry devices or the RAM output data bits which are the A input to the data selector. The outputs of L11, M11 and N11 are the register preset inputs for the program address counter.

The Computation Circuitry

(Refer to Appendix A, Figure A-9)

The computation circuitry is the core of the entire logic PCB. The purpose of this circuitry is to appropriately process all the information in the data instruction to the logic PCB while controlled by the sequencer logic which provides all the timing and control signals to the game logic. The ALU, a major circuitcomponent is comprised of three ALU devices N6, M6 and L6. These ALU's have the capability of

performing 16 arithmetic operations determined by inputs S0, S1, S2 and S3. These inputs re decoded by devices K2, K4 and J8. The operations process either of the A and B ALU inputs. The carry outputs (lo) are tied to look-ahead carry device L4 to be discussed later. After the operation has been performed the outputs from these ALU devices (F0-F11) are then fed to the primary and secondary accumulaters provide two functions: a Y and an X shift register, and arithmetic accumulators. The primary accumulator is comprised of shift registers F4, P4 and M4 (74LS194's). These shift registers are tied together providing 12 bits of computational capability. This output addresses the ALU, the RAM and the ROM for look-up purposes. All of these outputs while in the display mode supply the X register with X data. The secondary accumulator operates very much like the primary and is comprised of shift registers T4, R4 and N4. These also either address the program memory or provide data bits to the RAM and ALU depending on the state of the accumulator selector. The accumulator selector is comprised of data selector devices R2, N2 and T2 (74LS257). This data selector selects either input A or input B. Input A is the secondary accumulator bits SA0-SA11 and input B which the primary data bits PA0-PA11. These inputs are selectable by the select input line which originates from the A2 decoder (74LS107). When this bit is low it selects A input, when high it selects B input. Both select lines are commonly tied, therefore providing the identical select signal for N2, R2 or T2. The high speed look-ahead carry generator (74LS182) together with the ALU's provide a high speed ALU circuit.

The Audio Board

(Refer to Appendix A, Figure A-11)

The audio PCB generates all of the sounds produced by the game. It also provides the necessary amplification necessary to drive a speaker, mounted at the front of the game cabinet next to the coin mechanism.

All control signals enter the audio PCB via connector J4. Pin 2 of J4 is the 78 KHZ square wave generated at the logic PCB. This signal, amplified by op-amp U3 (TL081), clocks flip-flop U5A. The outputs of U5A are loaded into U5B by the 2MHZ oscillator. This oscillator, comprised of U10 hex inverters, also clocks counter U4. Device U4 counts up from the 9 value (1001) of the preset inputs A, B, C and D. This preset input is loaded into U4 when the Q output of U5B places a low at pin 9 of U4. After the preset input to U4 is loaded and the line goes high the counter counts to 15 (1111) where the carry output (pin 15 of U4) goes high and inverted by U10 at pin 9. Pin 8 of U10 then goes low which stops the counter at the count of 15. As long as the counter is counting the carry output at pin 15 of U4 is low maintaining the U5 flips-flops in a reset state. This reset places Q output of U5B at a high which removes the low line

to U4 at pin 9. The QA output of U4 produces steady bursts of three pulses .5 sec wide. The purpose of the circuitry is to triple the crystal controlled frequency from the logic board. This QA output then clocks U18 and divides the input clock frequency by either 32 or 64 at pins 8, 10 and 11 of U18 respectively. These signals are then used by succeeding sound generating circuits. The random noise generator which produces the crash sound is comprised of 8-bit shift register devices U20, U24 and exclusive OR gate U19. The output of this circuit (XPL) is the input to devices U11 (A, B, C, D) gated by the output of the transparent latch device U12. The outputs of this latch are determined by the last four bits of the 16-bit shifter comprised of 8-bit serial in, parallel/out shift registers U13 and U14. The inputs to this shift register are derived from control signals 02 and 03 generated by the logic board. The remaining 12 bits of he shift register are the preset inputs to the modulo N circuit; U15, U9 and U8. These devices are clocked at the frequency of the QA output of U4 when gated by the 01* signal at U6. This frequency is derived by the modulo N to a frequency determined by the twelve preset inputs from the 16-bit shift register. The output of this circuit at pin 15 of U14 is inverted loading the preset inputs (A, B, C, D) of each counter device. This output is also the trickle count input to the motor noise generator device U7, preset to 2.

The horn sound is generated by mixing the outputs of LS107 A and B. The inputs to these latches use signals at a frequency determined by counters U18 and U23. The tire squeal is a result of the output of the voltage controlled oscillator device (555). This device is controlled by the output of counter U24.

Steering Control

(Refer to Appendix A, Figure A-12)

The steering control electronics is capable of determining the direction and speed of the steering wheel rotation by the use of a film wheel encoder inprinted with clear and dark areas at its rim. The film wheel rotates with the steering wheel. The rim passes through a pair of electro-optical switch devices U1 and U2 (MCT81) which switch on or off corresponding to the dark and clear areas.

The operation of U1 and U2 are identical. As the rim of the wheel crosses the path of the light from LED inside U1 or U2, a pulse is generated at the emitter of the internal transistors of U1 and U2. Transistor devices Q1 and Q2 are emitter followers which provide a +5 volt pulse to the 74LS14 Schmidt trigger, switches from the low level pulses generated by the electro-optical switches. The output of the 74LS14 (pin 10) sets the steering direction by setting the direction bit at pin 3 of quad latch U4 (74LS175). The output of the 74LS14 (pin 8) is a clock signal that loads the data on inputs (DA-DD) into the U4 latches (QA-QD) simultaneously.

The state of the direction bit (high or low) is determined

3-11

by the direction of the rim through the electro-optical switch U1 and U2. Initially the steering film is factory adjusted.

As the steering wheel is turned to the right the clear area passes through U1 before U2; therefore, pin 4 of U4 goes high. The film continues to turn and the clock input at pin 9 of U4 goes high loading the high data (DA) into QA (pin 3). This high QA output indicates a right turn.

When the direction is reversed, the direction bit goes lo indication a left turn. Latches B, C and D connected together to form a shift register. This register propagates high levels each time the clock input at U4 (pin 9) goes high. After three clock pulses occur the latches are all loaded high.

These latches clear when pin 1 of U4 (CLR) goes low (momentarily 38 times per second) clear signal occurs before the latches are loaded. The program will recognize that the wheel was not turned.

PROM Board

The PROM board is a temporary board which contains all the program memory for the logic board in programmable read only memory devices. Eventually Vectorbeam will be as thoroughly satisfied with the program as you are and generate a pair of proprietary ROM's which will fit into their appropriate sockets presently located on the logic board.

Maintenance
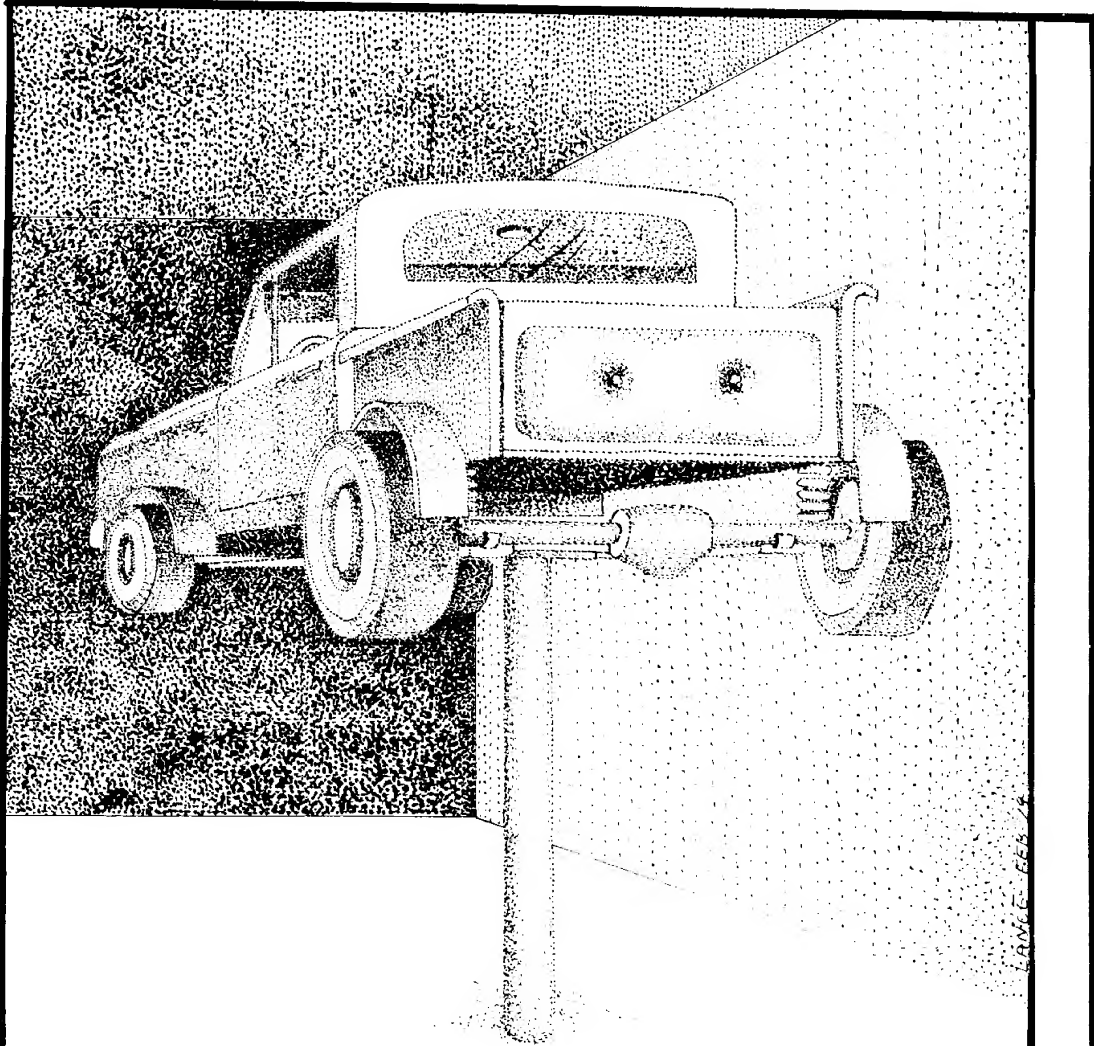
4

GENERAL

Occasionally an assembly may require repair, replacement or just simple adjustment. In such an event it is necessary for the technician to use this chapter. This chapter provides the technician with step by step instructions for removal or replaceable assemblies or items. It also shows how to adjust.

Display Monitor Adjustment Procedure

This display monitor adjustment procedure adjusts the linearity and convergence of the video display. It also allows the technician to adjust the volume control potentionmeter.

Volume Control Adjustment

(a) Adjust the volume control potentiometer (R30) located on the audio PCB assembly, illustrated in Figure 4-7, to the desired volume level while in the test pattern recall mode.

Before performing the display monitor adjustment procedure a test pattern must be recalled from the game program memory to the display by following the test pattern recall procedure.

Test Pattern Recall Procedure

(a) Remove rear access panel.
(b) Plug the game AC plug into AC wall receptacle.
(c) With right hand press and hold down the RED START button on the front panel.
(d) With the left hand pull out the INTERLOCK SWITCH. The screen should display the test pattern of Figure 4-1. If not try once more from step (c).

After recalling the test pattern visually, verify that the display looks close to that of Figure 4-1. If not refer to the following adjustment procedure.

Test Pattern Adjustment Procedure

(X and Y RC Time Constant Adjustment or the Inner Ends of X and Y Line Segments.)

(a) Turn the "X" RC time constant trimpot R61, and adjust the X (horizontal) lines until the two inner ends of each line segment just meet.
(b) Turn the "Y" RC time constant trimpot R58, and adjust the Y (vertical) lines until the two inner ends of each line segment just meet.
(c) The X and Y lines should meet at the center of the TV monitor screen, if not, check the related display electronics.
(d) The ends of the two "L" shaped line segments around the center of the display must meet to form the square of Figure 4-1.
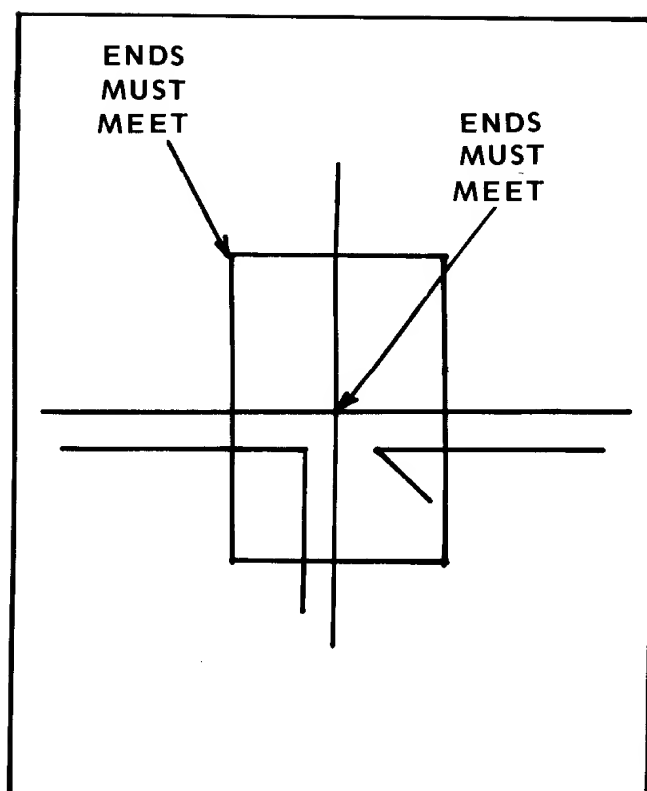
Figure 4-1 Test Pattern Display

X and Y Gain Adjustment

(a) Turn the X gain trimpot R60, indicated in Figure 4-7, and adjust the X (horizontal) lines until the two outer ends of each X line segments are 1/4 inch from the edge of the TV monitor screen.
(b) Turn the Y gain trimpot R54, indicated in Figure 4-7, adjust the Y (vertical) lines until the outer ends of each Y line segments are 1/4 inch from the edge of the TV monitor screen.
(c) If the outer ends of the line segment are not properly adjusting to 1/4 inch from the edge of the screen, center the display.

Centering the Display

(a) Turn the two CRT magnet rings, located on the neck neck of the CRT as illustrated in Figure 4-2, until the point where the X and the Y lines meet is centered on the monitor screen.

Steering Assembly Adjustment Procedure

The steering assembly is factory adjusted. The following procedure should be performed when the steering PCB or any other item of this assembly is replaced or removed for repair.

(a) Remove the control panel. This panel should have already been removed to replace or repair any

assembly on the control panel.

(b) If the steering wheel film (Figure 4-3) is replaced or removed, loosen the mounting screw at the hub and adjust the position of the wheel by centering the wheel so that the black and clear slits are set.

(c) Tighten the mounting screw to the film wheel.

(d) If the steering PCB has been replaced or removed loosen the four mounting screws.

(e) Adjust the board so that the film wheel fits dead center between the two optical switches as illustrated in Figure 4-3.
When satisfied with the setting of step (e) tighten all four screws.

Shifter Assembly Adjustment Procedure

The shifter assembly is factory adjusted, but there may be occasion to adjust it for smoother operation.

The shifter assembly is comprised of a mechanical shifter rod with a bar magnet attached to its tip (see Figure 4-4), which affects the appropriate reed switch when in close proximity. There are three reed switches, one for each gear except fourth. The switch should make electrical contact when the shifter's magnetic tip is about 1/4 inch away from the glass reed switch case.
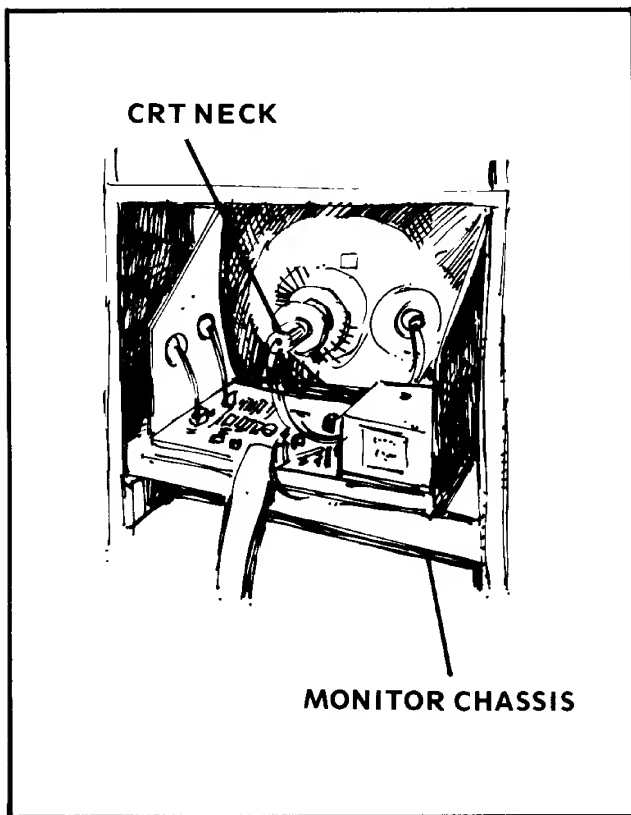
Figure 4-2 CRT Magnetic Centering Rings Location
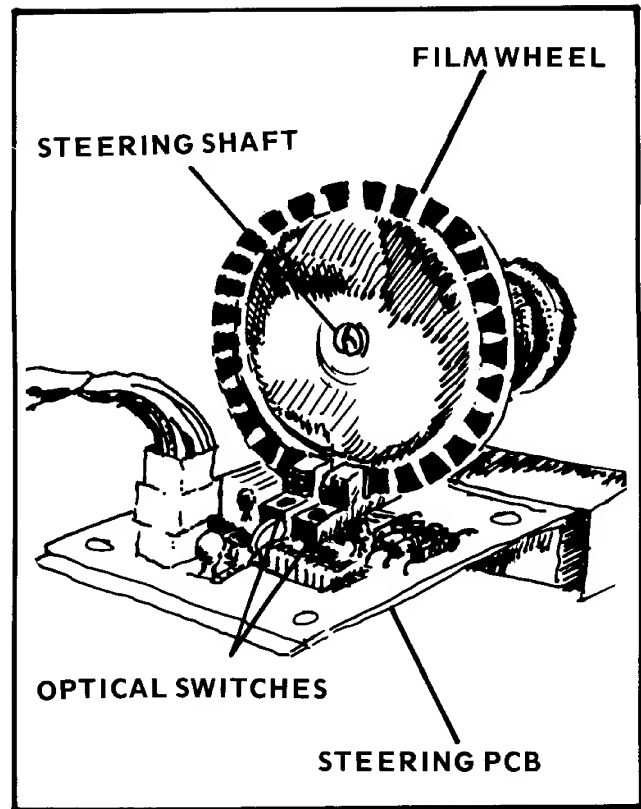
Figure 4-3 Steering Wheel Film Set-up and Adjustment

(a) Remove the control panel.

(b) Set the shifter to first gear position.

(c) Connect the leads of an ohmeter (set to X1) across the first gear reed switch. See Figure 4-8.

(d) If the ohmeter does not read continuity across the read switch, loosen he two mounting screws to the board with the read switch of interest, and move the board until the magnet covers maximum area of the reed switch.

(e) Place the shifter into second gear.
Move the board until the magnet covers maximum

(g) Tighten the board screws.

(h) Return the shifter to first.

(j) Next, bend the board in carefully until the reed switch is about 1/4 inch away from the magnet at the tip of the shifter. The reed switch should be making contact. If not the reed switch is probably defective.

(k) Place the shifter into second.

(l) Connect the leads of an ohmeter (set at X1) across the second gear reed switch.

(m) Continuity should exist. If not return to step (b) until it does. Be sure this reed switch is not defective.

(n) The third gear switch may be adjusted as with the first and second.

NOTE

There is no fourth gear read switch.
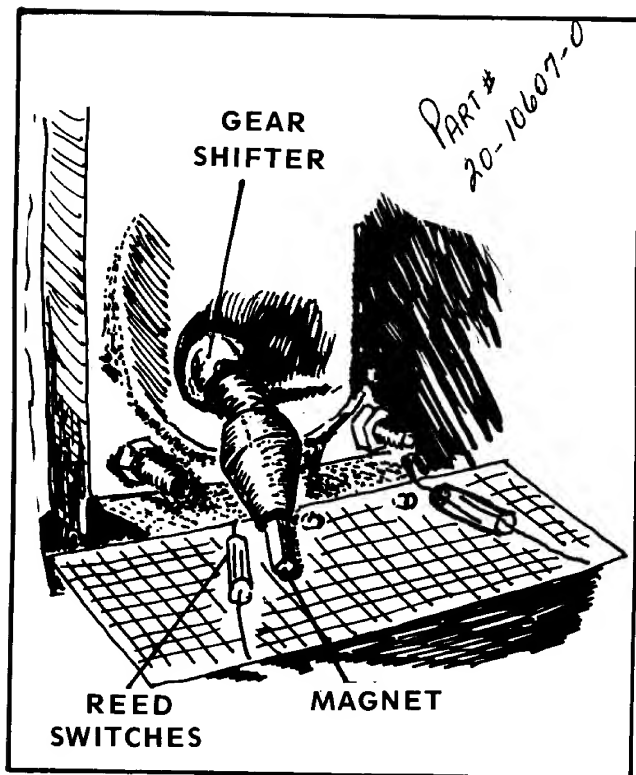
Figure 4-4 Shifter Bar Magnet

Control Panel Removal

The Speed Freak control panel may have to be removed when the technician is required to maintain the control panel hardware (i.e., steering, wheel assembly, LED pushbutton switch, shifter assembly).

The proper procedure for removing the control panel is as follows:

(a) Remove the AC power.
(b) Remove the rear access panel.
(c) Disconnect the cntrol panel Molex connector mounted to a metal bracket.

(d) Remove the ground braid connected to the steering assembly.
(e) Remove the four wing nuts from the control panel mounting bolts.
(f) Remove the control panel. Refer to Figure 4-5.

Plexiglass Shield and Plex Retainer Removal

The plexiglass shield and the plex retainer should be removed using the following instructions:

(a) Remove the rear access panel.
(b) Using either a 7/16'' nut driver or a large blade type screwdriver, back off the two tensioning 1/2 to 5/8

inch hex slotted head bolts. These bolts are located inside the game cabinet on either side of the face of the CRT, as illustrated in Figure 4-6.

(c) Sharply press in on the front of the plexiglass shield.
(d) With fingers still pressing in on shield raise the shield up until the bottom edge of shield clears the metal lip.
(e) Remove the shield.

Plex Retainer Removal

(f) Sharply press in the top end of the plex retainer, and raise it up until the bottom edge clears the metal.
(g) Remove the plex retainer.

Plex Retainer Replacement

(h) First slide the bottom edge in over the metal lip then push the plex retainer back into place.

Shield Replacement

(j) Slide the top edge of the shield into the slot.
(k) Push back the shield then slide it down behind the metal lip.
(l) Carefully tighten the tensioning bolts.

Vectorbeam video games are relatively new, but designed to endure their rugged environment. Some problems will occur and most are evident as a broken steering wheel or gear
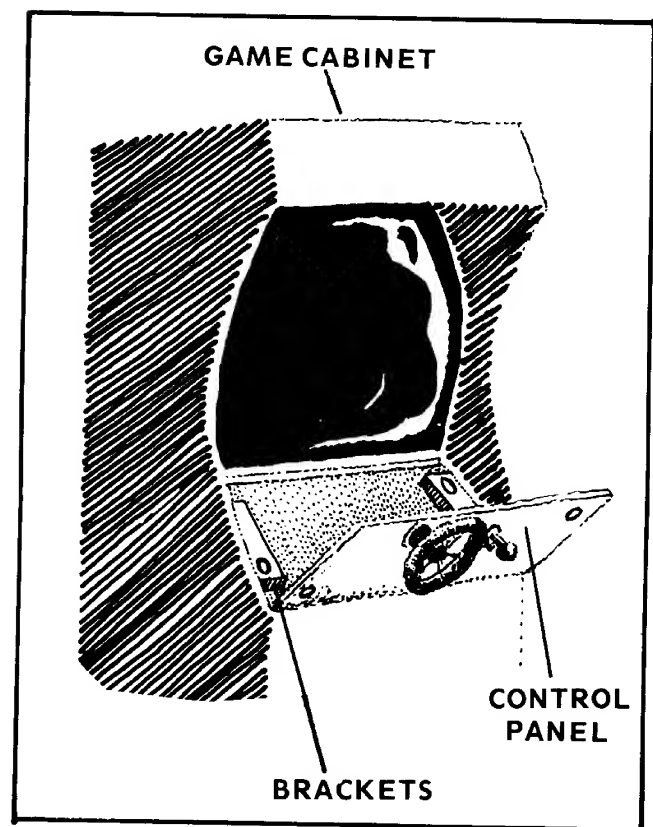
Figure 4-5 Control Panel Removal

4-4

shifter or even a burnt out monitor. In other cases the problems must be solved with the experience of qualified Vectorbeam service technicians. As a result of all their efforts a troubleshooting chart has been devised to aid you with the most likely solutions to your game problems. Refer to Table 4-1.
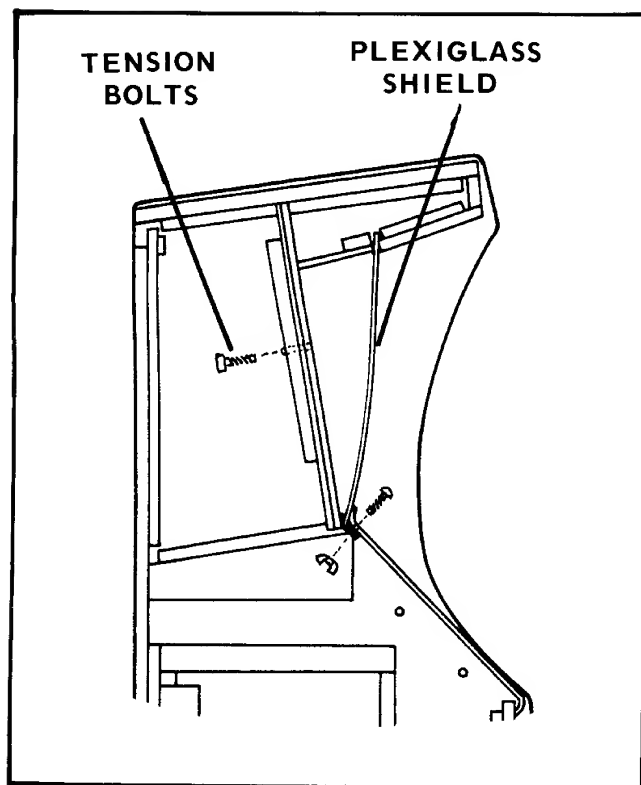
Figure 4-6 Plexiglass Shield and Plex Retainer Removal

Table 4-1
Troubleshooting Chart

PROBLEM	PROBABLE SOLUTIONS
Circuit Breakers Blow	Disconnect AC line power to Display PCB If breakers continue to blow, check for shorted speaker coil Verify proper operation of ±15 volt regulators U1 and U16 Check audio drive transistor Q1 and Q2 with ohmeter Check logic PCB for lighted LED, located near power connector LED should not be on Measure voltage at pins 10 and 20 at T13 Voltmeter should read 4.8 VDC Remove Molex connector U4 and U5 Check power transistors Q110, Q111, Q210 and Q211 located on heatsinks with ohmeter Check diodes CR34 and CR35 located on display PCB Disconnect CRT yoke by removing Molex connector from display PCB Remove CRT socket. Reset breakers Apply AC line power. If unit fails to blow circuit breakers, check transistors Q1, Q3 and Q1 located on horizontal deflection section of display PCB Check diodes CR12 and CR22 located in vertical drive section Check diodes CR1 and CR11 located in horizontal drive section Check voltage at horizontal and vertical DAC's at pins 13, 14 and 22 Measure outputs of amplifiers U2 and U4 DC offsets Signal should be a ±2 volts centered around 0 volts Measure outputs of DAC's U5 and U11 Signals should be ±4 volts centered around 0 volts
Display Jitters	Check vertical size potentiometer R54 for wiper noise by turning R54 Briskly while observing screen. Check R54 pins for weak solder connections.

Table 4-1   Troubleshooting Chart

PROBLEM	PROBABLE SOLUTIONS
	Check horizontal size potentiometer R60 for wiper noise by turning R60 briskly while observing screen. Check R60 pins for weak solder connections. Check DACs U1 and U5 pins for poor solder connections. Check Molex connector pins for good connections. Check analog switch device U3 for loose pins or poor solder connections on socket.
One-inch Horizontal Line, Displayed on monitor	Check for open power transistors Q110, Q111, Q210 and Q211 using an ohmmeter. Check Molex connector to power transistors for open or weak solder connection.
No Display	Check the neck of CRT for glowing filament. If filament is not glowing, check brown and black twisted wire pair to CRT plug for 6.3 VAC. LED on logic PCB should not be on. Zero scope. Connect scope probe to yellow beam wire at display PCB. Set brightness full clockwise. Data pulses should be 50 volts at an 80-100 VDC base. If no data present, connect socpe probe to pin 8 of U6. Then dynamically check Q19 for an open collector to emitter junction (41VDC on emitter). Check Q20 and Q22 with ohmeter. Connect scope probe to the cathode of CR32 and check for a full-wave, unregulated spot kill voltage (approximately 25 volts DC). If not check power supply fuse and check Q14 and Q21. Check 18KV at anode cap of CRT. (Use high voltage probe.) If high voltage not present see No High Voltage remedy. Check CRT neck for broken pins. Check the seating of the CRT plug.

Table 4-1   Troubleshooting Chart

PROBLEM	PROBABLE SOLUTIONS
Narrow Line Displayed	Check for open yoke winding Check yoke Molex connector for weak or cracked solder connections Check Molex connector continuity to Q110, Q111, Q210 and Q211. Check for open power transistors Q110, Q111, Q210 and Q211

Half Display
 	
**(a) Left Half
    Missing**
**(b) Right Half
    Missing**
**(c) Top Half
    Missing**
**(d) Bottom Half
    Missing**
	
	Check Q1, Q2 and Q210 with ohmmeter
	
	Check Q5, Q11 and Q211 with Ohmmeter
	
	Check Q6, Q12 and Q111 with ohmmeter
	
	Check Q9, Q10 and Q110 with ohmmeter

Brightness Potentiometer has no Control	Check intensity potentiometer R91 wiper Check for open C28 capacitor Check potentiometer pins for weak solder connections
Circuit breakers Blow after warm-up	Measure DC voltage at pins 10 and 20 of device T13 on the logic PCB. Meter should read 4.8 VDC Check for thermally sensitive 723 regulator devices on the power supply Check for thermally sensitive devices on the Logic PCB

Table 4-1   Troubleshooting Chart

PROBLEM	PROBABLE SOLUTIONS
	Remove AC line power to game Remove CRT plug from CRT neck Return AC power Measure pin 3 of CRT plug with oscilloscope. Meter should read 400 VDC. Measure pin 4 of CRT plug with oscilloscope. Meter should read 200 VDC. Connect scope probe to yellow beam wire at display PCB. Set intensity control to full clockwise. Data pulses should be 50 volts peak to peak at an 80-100 VDC base. Measure the AC voltage at pins 1 and 8 of the CRT plug. Meter should read 6.3 VAC.
No High Voltage	Measure DC voltage of regulator U12 Meter should read +18 VDC If not present, measure DC voltage at capacitor C25. Meter should read +25 VDC. Measure DC voltage of regulator U9 Meter should read -18 VDC. If not, measure DC voltage at capacitor C17. Voltmeter should read —25 VDC. Lift winding from pin 3 of high voltage transformer T1. Measure +18 voltage regulators If +18 VDC present check Q31 for short Check capacitors C32 and C34 for shorts Check diodes CR46 and CR47 Check 6KV at black wire Check CRT for bent pins
Dot Display	Check analog switch U3 Inspect yoke connector for poor solder connections Check for open yoke winding Measure DC voltage at capacitor C7 Meter should read +25 VDC Measure DC voltage at capacitor C1 Meter should read -25 VDC

Table 4-1   Troubleshooting Chart

PROBLEM	PROBABLE SOLUTIONS
	Check for thermal sensitivity of devices U2, U3, U4, U5 and U11 Check operation of DAC U5 Check operation of DAC U11 Check for thermal sensitivity of Q15, Q10, R12 and R39
No Audio	Check for open speaker coil Check transistors 2N6292, 2N6107 in heatsinks with ohmmeter Check OD amp U21 for proper operation Measure DC voltage at output pins of +5 volt regulators U1 and U16 Check for illuminated LED on logic PCB If LED ''on'' replace device F2 on logic PCB Check open wiper on volume potentiometer R12
Does Not Provide Game time When Coin Inserted	Remove AC line power Remove 3-pin Molex connector to coin mechanism Check switch closure with ohmmeter. (Center pin of connector is common) Verify one pin normally open and the other normally closed Press coin device at coin mechanism. Pins should change state. Normally open to normally closed and vice versa. Check flip-plop A4 on logic PCB with logic probe on pin 3 of A4. Press coin lever; Pin should change state. With logic probe on pin 6 of A4, press coin lever; pin should change state. Replace device F2 on logic board.
Coin counter does not Work	Check transistor 2N3904 and 2N6292 on logic PCB with ohmmeter Disconnect coin counter Molex connector Measure DC voltage on red wire Meter should read +25 VDC Check power connector (J1) to logic PCB Check electrical connection at pin 3 of J1 (white wire)

Table 4-1   Troubleshooting Chart

PROBLEM	PROBABLE SOLUTIONS
No Tire Squeal	Connect scope probe to pin 3 of oscillator U22 Verify a 1.8msec FM square wave. Connect scope probe to pin 7 of U22. Scope should display random TTL level pulses. If not see he "No Crash Sound" remedy. Check capacitor C23 for an open Connect jumper from pin 2 of U6 to +5 VDC. If tire squeal present, replace device F2 on logic PCB. Remove jumper.
No Horn or Wrong Horn Frequency	Connect a jumper from pin 9 of U2 to GND. If horn present, replace device F2 logic PCB. Remove jumper. Connect scope probe to pin 15 of U23. Pulses should be present. Check operation of inverter U19. Connect scope probe to pin 5 of U17. Scope should display a 3.0 msec square-wave. Connect scope probe to pin 3 of U17. Scope should display a 2.2 msec square-wave.
No Crash Sound	Connect jumper from pin 3 of U12 to +5 VDC. If crash sound present, replace device F2 on logic PCB Connect scope probe to pin 14 of U24. Scope should display random digital pulses (white noise). Check latch device U12 Check crash gate device U11
No Acceleration Audio	Replace device F2 on logic PCB Check device U7. Observe pulses on pins 12, 13, 13 and 14 Check Modulo-N counter circuit comprised of device U8-U9 and U15
No Start Light	Connect a jumper from pin 5 of U2 to ground. Start light should be on. If on replace F2 on logic PCB. Remove jumpers Check device U2 Replace Q4 Replace start switch

Table 4-1   Troubleshooting Chart

PROBLEM	PROBABLE SOLUTIONS
Car suddenly Swerves to Either Side	Connect jumpers from pin 1 of 74LS178 on the steering PCB to ground Check for logic lows at pins 2, 4, 6 and 12 of 74LS14 on the steering PCB. Check harness continuity with ohmmter from pins 2, 4, 6 and 12 of 74LS14 on the steering PCB to respective pins 1, 2, 3 and 4 of device D4 on the logic PCB. Remove connector J3 at the logic PCB Check pins 1, 2, 3 and 4 of D4 for high logic leve. If not replace D4. Reconnect connector J3 Replace resistor pull-up DIP D2. Remove jumpers
Difficult to Control Car in Higher Gears	Connect scope probe 1 of dual trace scope to pin 4 of device 74LS175 on steering PCB. Connect scope probe 2 to pin 9 of device 74LS175. Pulses should be displayed on scope as wheel rotates. These two pulse trains should be square waves 90 degrees out of phase with each other. If pulses not present, replace appropriate optical sensor. Using a freon agent (i.e. SPRA-FREEZ or equivalent) spray optical sensor. Replace thermally sensitive sensor. Examine disc capacitors or the underside of steering PCB Assure leads do not touch other pins or paths. Inspect coder disc at end of steering wheel shaft. Assure no dust or nicks in the teeth of coder

J4
VERTICAL/HORIZONTAL
DEFLECTION
COILS

J5
VERTICAL
DEFLECTION
DEVICES
Q110, Q111
(SEE NOTE 1)

R54
Y DRIVER
INPUT
ADJUST

U5
Y DAC

U4

R59
YRC TIME
CONSTANT
ADJUST

U3
ANALOG
SWITCH

MI
TRIPLER

FOCUS
CONTROL

J3
HORIZONTAL
DEFLECTION
DIVICES
Q210, Q211
(SEE NOTE 1)

X
DRIVER
INPUT
ADJUST
R60

R6
X RC TIME
CONSTANT
ADJUST

U1
X DAC

J1
RIBBON
CONNECTOR

U2

J2
L.V.
POWER

R91
BRIGHTNESS
CONTROL

TI
H.V.
TRANSFORMER

Figure 4-7 Display Monitor PCB
Testpoint and Adjustment Layout

4-13

Figure 4-8 Logic PCB
Testpoint and Adjustment Layout

INPUT
FROM
LOGIC PCB

Q3

Q1

Q4

VOLUME
CONTROL

Q2
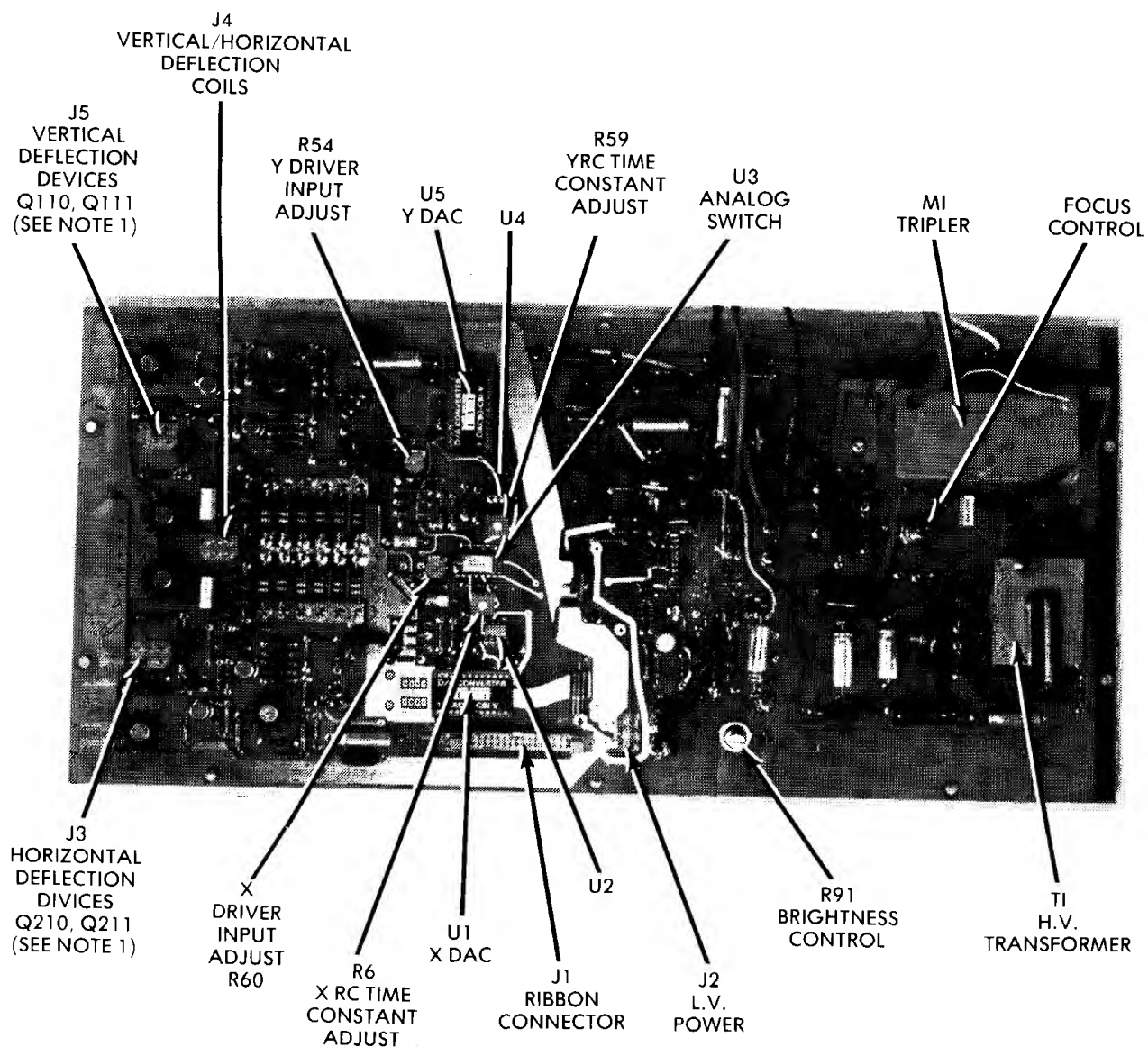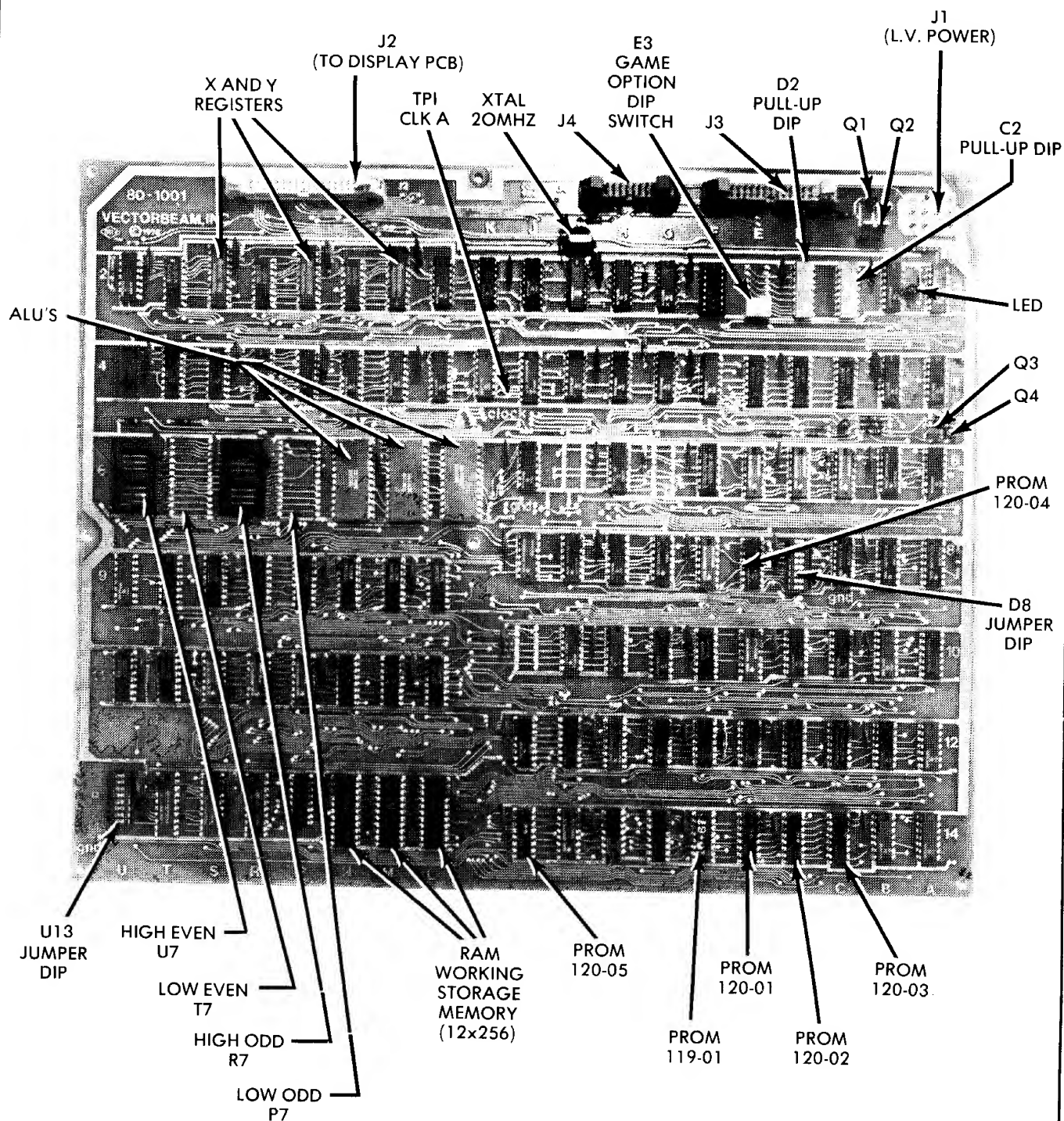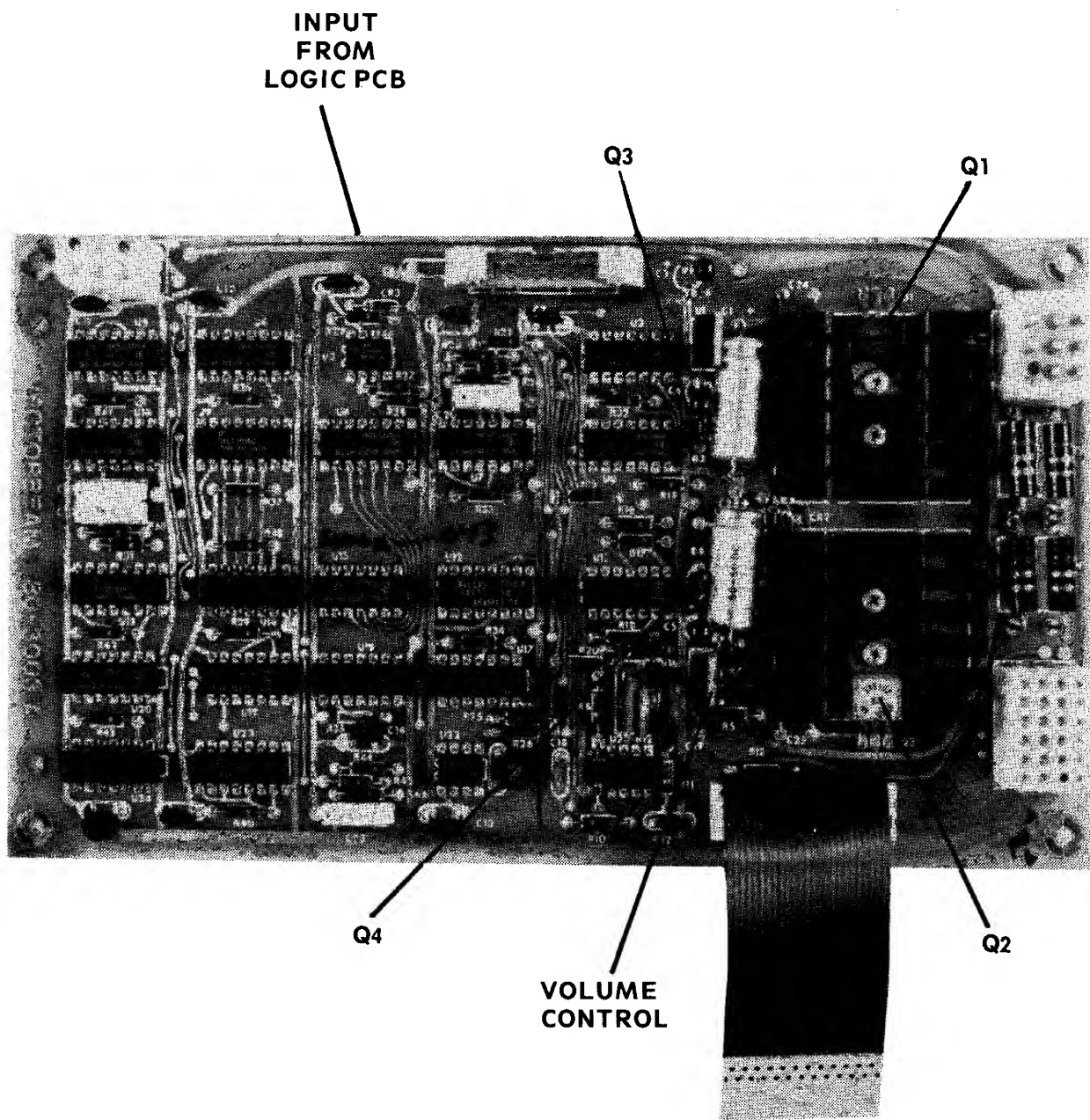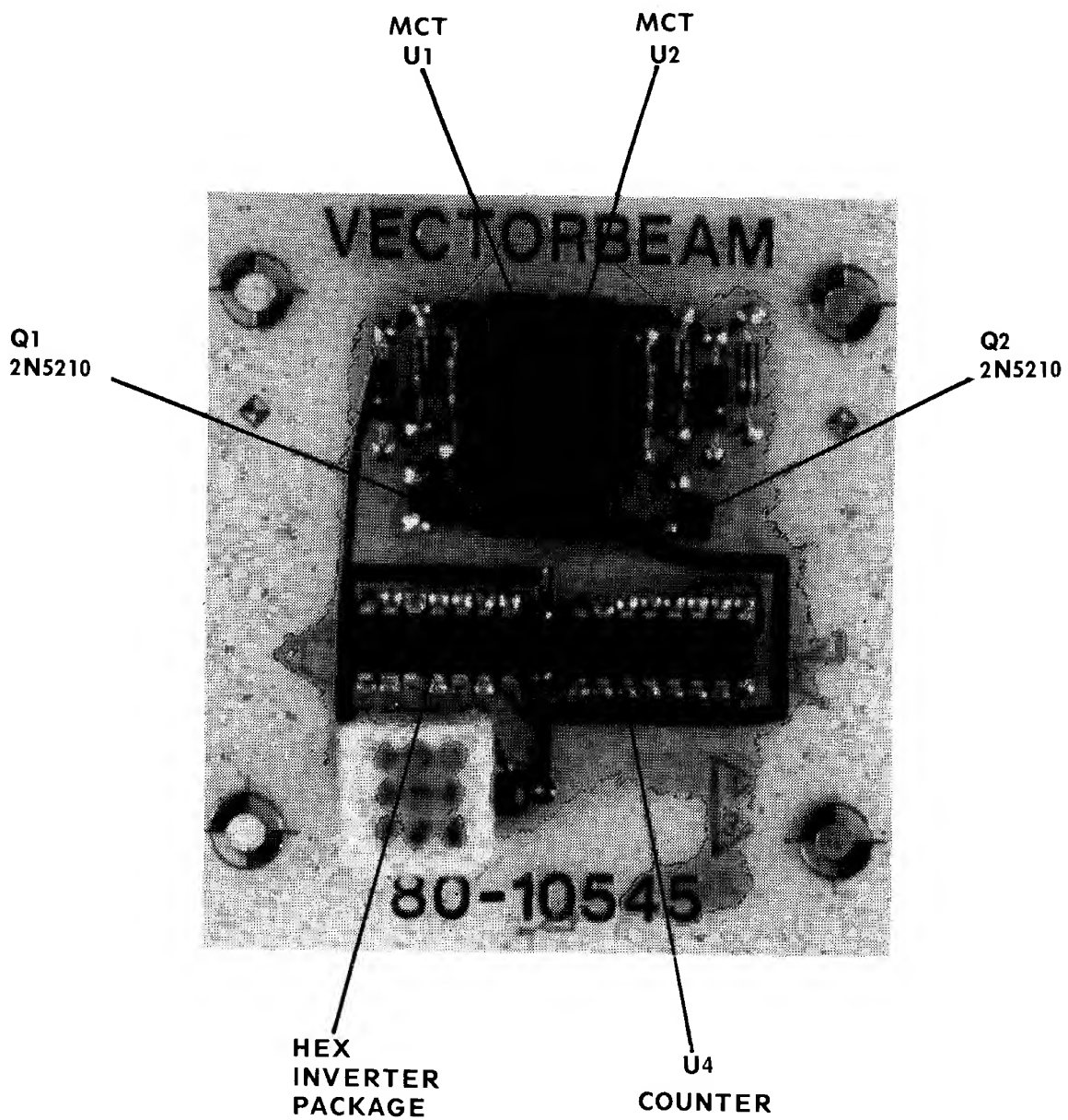
Figure 4-9 Audio PCB Testpoint and Adjustment Layout

Figure 4-10 Steering PCB   Testpoint and Adjustment Layout
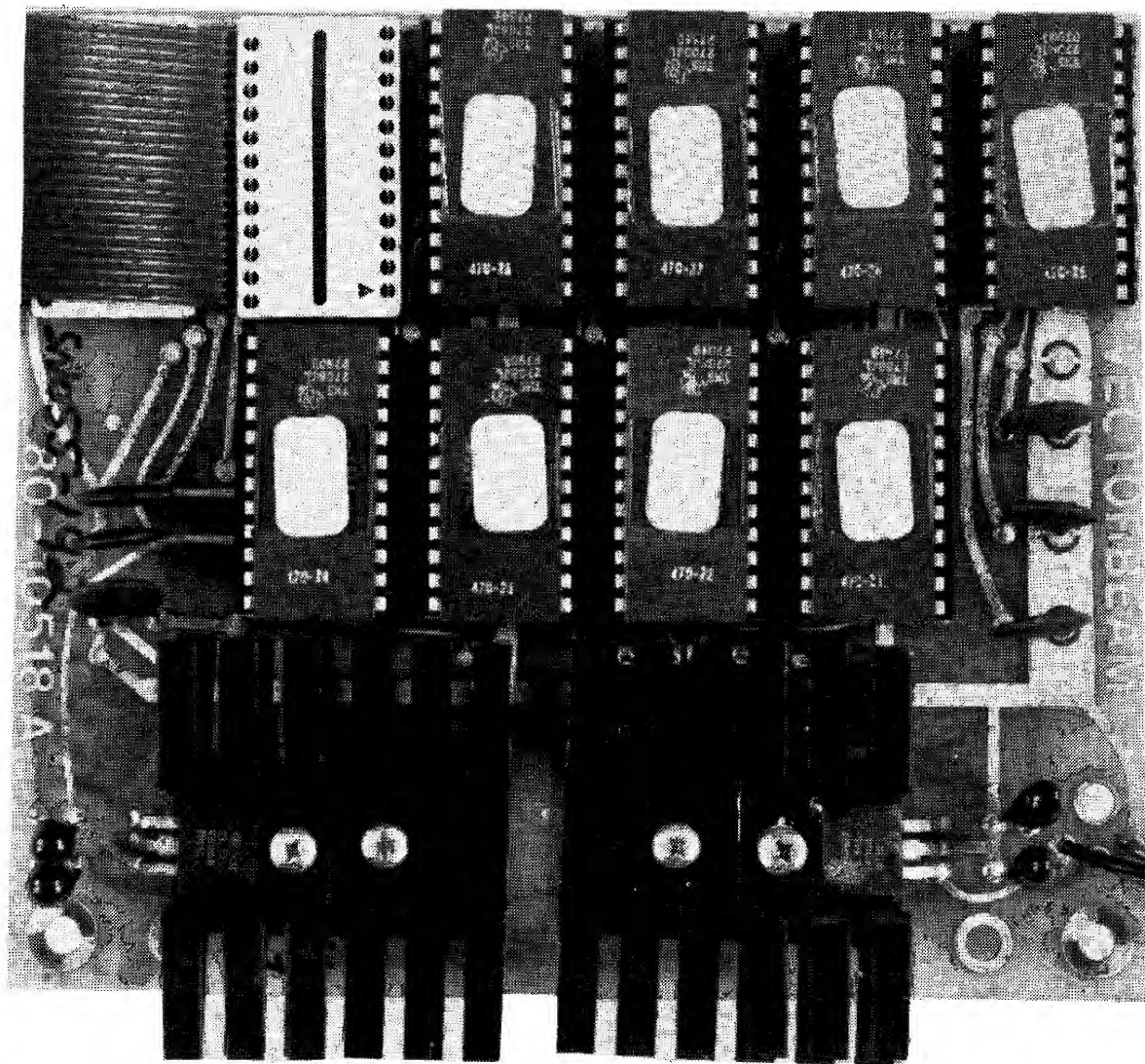
Figure 4-11 PROM PCB
Testpoint and Adjustment Layout

ILLUSTRATED PARTS BREAKDOWN

5

ITEM	PART NUMBER	DESCRIPTION
1	35-10179-01	Test Points
2	36-10175-01	Socket, 16 PIN I.C. DIP
3	36-10176-01	Socket, Amp 16 Jumper
4	36-10395-01	Socket, 24 PIN
5	37-10178-01	Switch, 2 Pole Dip
6	41-10160-01	Con, Molex 09-18-5127, 12 PIN PC, F4
7	41-10161-01	Con, 34 PIN, 3M#3431-2202
8	41-10162-01	Con, 16 PIN, 3M#3408-2202
9	41-10163-01	Con, 26 PIN, 3M#3429-2202
10	44-01001-01	IC, ROM (1001)
11	44-01002-01	IC, ROM (1002)
12	44-10110-01	IC, 74S00
13	44-10111-01	IC, 74S02
14	44-10112-01	IC, 74S04
15	44-10113-01	IC, 74S08
16	44-10114-01	IC, 74S10
17	44-10115-01	IC, 74S32
18	44-10116-01	IC, 74S113
19	44-10117-01	IC, 74S158
20	44-10118-01	IC, 74S182
21	44-10119-01	IC, 74S288 PROM, DROM, 1
22	44-10120-01	IC, 74S288 PROM, DROM, 2
23	44-10120-02	IC, 74S288 PROM, DROM, 3
24	44-10120-03	IC, 74S288 PROM, DROM, 4
25	44-10120-04	IC, 74S288 PROM, DROM, 5
26	44-10120-05	IC, 74S288 PROM, DROM, 6
27	44-10121-01	IC, 74LS00
28	44-10122-01	IC, 74LS02
29	44-10123-01	IC, 74LS04
30	44-10124-01	IC, 74LS08
31	44-10125-01	IC, 74LS10
32	44-10126-01	IC, 74LS27
33	44-10127-01	IC, 74LS32
34	44-10128-01	IC, 74LS75
35	44-10129-01	IC, 74LS85
36	44-10130-01	IC, 74LS86
37	44-10131-01	IC, 74LS107
38	44-10132-01	IC, 74LS151
39	44-10133-01	IC, 74LS157
40	44-10134-01	IC, 74LS163
41	44-10135-01	IC, 74LS164
42	44-10136-01	IC, 74LS194
43	44-10137-01	IC, 74LS259
44	44-10138-01	IC, 74LS298

Logic PCB Assembly
Parts List
38-10001-01 Rev F

ITEM	PART NUMBER	DESCRIPTION
45	44-10139-01	IC, 74LS377
46	44-10140-01	IC, 74LS393
47	44-10141-01	IC, 25LS818
48	44-10142-01	IC, 2101A-2
49	44-10144-01	IC, 7425
50	44-10150-01	IC, 74265
51	44-10340-01	IC, 74LS257
52	53-10054-01	Res, CC, ¼W, 5% 100 OHM
53	53-10058-01	Res, CC, ¼W, 5% 330 OHM
54	53-10059-01	Res, CC, ¼W, 5% 470 OHM
55	53-10062-01	Res, CC, ¼W, 5% 1 K
56	53-10064-01	Res, CC, ¼W, 5% 2.2 K
57	53-10066-01	Res, CC, ¼W, 5% 4.7 K
58	53-10070-01	Res, CC, ¼W, 5% 10 K
59	53-10072-01	Res, CC, ¼W, 5% 20 K
60	53-10073-01	Res, CC, ¼W, 5% 30 K
61	53-10080-01	Res, CC, ¼W, 5% 560 K
62	53-10099-01	Res, PACK, IK D-16-15-2-1K
63	63-10030-01	CAP, TANT, DIP, 25/35V, 3.3MF
	63-10031-01	CAP, TANT, DIP, 35V, 33MF
	63-10040-01	CAP, DISC, 50V, .02MF
	63-10042-01	CAP, DISC, 100V, 680PF
	65-10026-01	DIODE, SI, SIGNAL 1N914B
	65-10177-01	LED, TIL220
	66-10011-01	TRANSISTOR, NPN 2N3904
	66-10012-01	TRANSISTOR, NPN 2N6292
	69-10214-01	CRYSTAL, 20 MHZ
	80-01001-01	Logic Board

Display PCB Assembly
Parts List
38-10007-01 Rev. H

ITEM	PART NUMBER	DESCRIPTION
1	20-10170-01	Heatsink 6070B
2	20-10393-01	Heatsink Wakefield 204AB
3	25-10187-01	Nut, Hex #6-32
4	25-10192-01	Nut, Hex #4-40
5	25-10195-01	Screw, Mach. #4-40 x 3/8, PH PH
6	25-10208-01	Lockwasher, STD. #4
7	25-10209-01	Lockwasher, International #6
8	25-10336-01	Screw, Mach. #6-32 x ½ Binding Hd.
9	36-10174-01	Socket, CRT
10	36-10175-01	Socket, 16 Pin I.C. DIP
11	40-10173-01	Tripler, Varo MH919
12	41-10156-01	Con, Molex 09-18-5960, 6 Pin PC, F3
13	41-10157-01	Con, Molex 09-18-5062, 6 Pin PC, F5
14	41-10158-01	Con, Molex 09-18-5069, 6 Pin PC, F1
15	41-10161-01	Con, 34 Pin, 3M #3431-2202
16	43-10171-01	Choke, 100 Microhenry
17	43-10172-01	Transformer, High Voltage HV18
18	44-10143-01	IC, 7406
19	44-10145-01	IC, 7805
20	44-10146-01	IC, 7815
21	44-10147-01	IC, 7818
22	44-10148-01	IC, 7915
23	44-10149-01	IC, 7918
24	44-10152-01	IC, TL081
25	44-10154-01	IC, DAC80 D/A Converter
26	44-10155-01	IC, LF13331 Analog Switch
27	51-10105-01	Pot, 10K A-B #JA1N056S103UA
28	51-10106-01	Pot, 1 Meg A-B #JA1N056S105UA
29	51-10107-01	Trimpot, 100 OHM Bourne 3352P1
30	51-10108-01	Trimpot, 5 K Bourne 3352P2
31	53-10051-01	Res, CC, ¼W, 5% 15 OHM
32	53-10052-01	Res, CC, ¼W, Zi-CHM
33	53-10053-01	Res, CC, ¼W, 5% 47 OHM
34	53-10054-01	Res, CC, ¼W, 5% 100 OHM
35	53-10057-01	Res, CC, ¼W, 5% 200 OHM
36	53-10058-01	Res, CC, ¼W, 5% 330 OHM
37	53-10059-01	Res, CC, ¼W, 5% 470 OHM
38	53-10061-01	Res, CC, ¼W, 5% 820 OHM
39	53-10062-01	Res, CC, ¼W, 5% 1 K
40	53-10063-01	Res, CC, ¼W, 5% 1.8 K
41	53-10064-01	Res, CC, ¼W, 5% 2.2 K
42	53-10065-01	Res, CC, ¼W, 5% 3 K
43	53-10066-01	Res, CC, ¼W, 5% 4.7 K
44	53-10067-01	Res, CC, ¼W, 5% 5.6 K
45	53-10070-01	Res, CC, ¼W, 5% 10 K

ITEM	PART NUMBER	DESCRIPTION
46	53-10076-01	Res, CC, ¼W, 5% 68 K
47	53-10083-01	Res, CC, ½W, 5% 1.2 K
48	53-10084-01	Res, CC, ½W, 5% 2.2 K
49	53-10085-01	Res, CC, ½W, 5% 8.2 K
50	53-10086-01	Res, CC, ½W, 5% 10 K
51	53-10087-01	Res, CC, ½W, 5% 510 K
52	53-10088-01	Res, CC, ½W, 5% 4.7 MEG
53	53-10089-01	Res, CC, 1W, 5% 2.7 OHM
54	53-10091-01	Res, CC, 1W, 5% 360 OHM
55	53-10092-01	Res, CC, 1W, 5% 10 K
56	53-10093-01	Res, WW, 8W 150 OHM, OHMITE TYPE 200
57	53-10095-01	Res, WW, 8W 500 OHM, OHMITE TYPE 200
58	53-10096-01	Res, Metal Film, 1% 1.43 K, RN55D
59	53-10097-01	Res, Metal Film, 1% 2.1 K, RN55D
60	53-10098-01	Res, Metal Film, 1% 10 K, RN55D
61	53-10101-01	Res, CC, ½W, 5% 47 OHM
62	53-10102-01	Res, CC, 2W, 5% 100 OHM
63	53-10379-01	Res, WW, 2W, 22 OHM DALE RS2B
64	63-10029-01	CAP, 50V, 50MF, Sprangue TE1307
65	63-10033-01	CAP, TANT, DIP, 50V, 2.2MF
66	63-10034-01	CAP, TANT, DIP, 35V, 4.7MF
67	63-10041-01	CAP, DIST, 100V, .1MF
68	63-10043-01	CAP, 100V, 5MF
	63-10044-01	CAP, ALUM, AXIAL LEAD, 100V, 10MF
	63-10045-01	CAP, ALUM, AXIAL LEAD, 150V, 10MF
	63-10048-01	CAP, Polycarbonate, 200V .022MF
	63-10049-01	CAP, 250V, .068MF PLESSEY
	63-10050-01	CAP, 100V, .1MF PLESSEY
	63-10215-01	CAP, DISC, 100V, .005MF
	63-10380-01	CAP, TABULAR .1MF 600V Sprague 6PS-P10
	65-10024-01	Rectifier, FR MR818
	65-10025-01	Diode, High Volt, MR250-2
	65-10026-01	Diode, SI, SIGNAL 1N914B
	65-10027-01	Rectifier, 1 AMP, 1N4003
	66-10011-01	Transistor, NPN 2N3904
	66-10013-01	Transistor, NPN 2N2102
	66-10014-01	Transistor, NPN 2N5210
	66-10015-01	Transistor, NPN 2N5320
	66-10016-01	Transistor, PNP 2N5322
	66-10017-01	Transistor, NPN 2N5550
	66-10021-01	Transistor, PNP 2N3906
	66-10023-01	Transistor, NPN TIP41C
	80-02001-01	Display Board
	87-10382-01	Ground Wire Assy - Display Board

HEATSINK
20-10229

2N 5876

2N 5878

6-32-N.C.x¹/₂ LONG
BINDING HEAD
MACHINE SCREW
25-10336
4 – PLACES

MICA WASHER
2 – PLACES . USE
THERMAL
GREASE BOTH
SIDES.

WIRE HARNESS, SEE NOTE
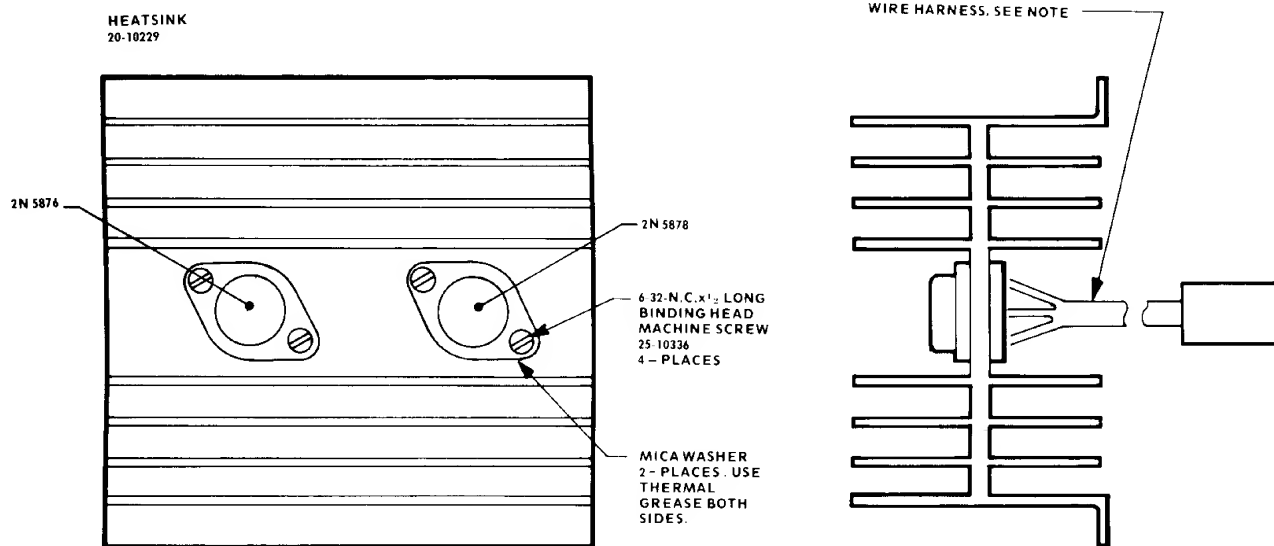
NOTE:
2 – ASSEMBLIES REQUIRED: 38-10006-01 WITH HARNESS 87 10315 01, 38 10006 02 WITH HARNESS
HARNESS 87-10315-02

BEND LUG TO CLEAR HEATSINK
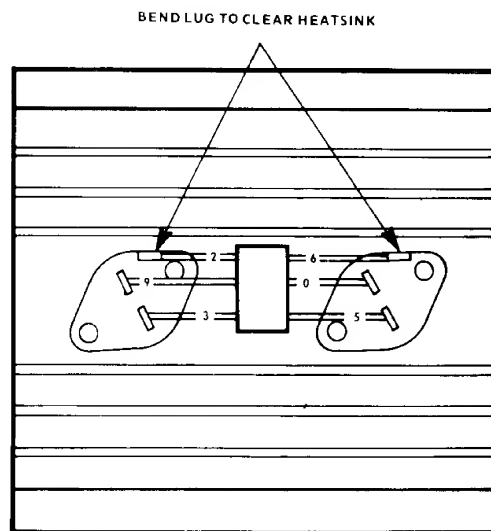
Figure 5-1   Heat Sink Assembly
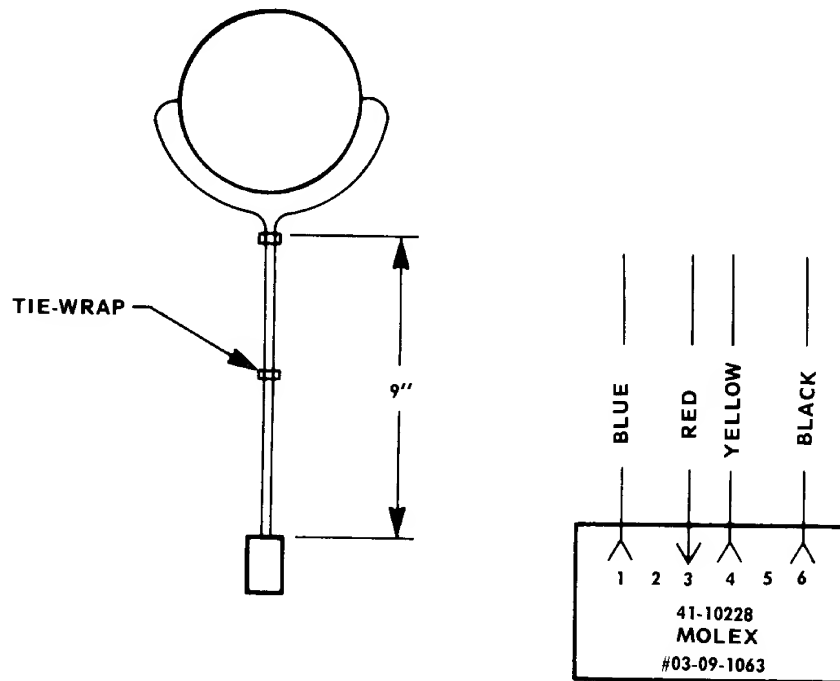
Figure 5-2   Yoke Assembly

Yoke Assembly
Parts List
38-10344-01 Rev. A

ITEM	PART NUMBER	DESCRIPTION
	35-10224-01 35-10225-01 40-10268-01 41-10228-01	Pin, Female, Molex 02-09-1118 Pin, Male, Molex 02-09-2118 Yoke, Broy 746 Con, Molex 03-09-1063, 6 Pin Recept

Heat Sink Assembly (Front)
Parts List
38-10006-01 Rev. B

ITEM	PART NUMBER	DESCRIPTION
1	09-10337-01	Heatsink Compound, Wakefield #120
2	20-10229-01	Heatsink (2107)
3	25-10336-01	Screw, Mach. #6-32 × ½ Binding Hd.
4	66-10018-01	Transistor, PNP 2N5876
5	66-10019-01	Trnasistor, NPN 2N5878
6	87-10315-01	Harness Assembly, Front (for heatsink)

Heat Sink Assembly (Rear)
Parts List
38-10006-01 Rev. B

ITEM	PART NUMBER	DESCRIPTION
1	09-10337-01	Heatsink Compound, Wakefield #120
2	20-10229-01	Heatsink (2107)
3	25-10336-01	Screw, Mach. #6-32 × ½ Binding Hd.
4	66-10018-01	Transistor, PNP 2N5876
5	66-10019-01	Transistor, NPN 2N5878
6	87-10315-02	Harness Assembly, Rear (for Heatsink)

Display Assembly
Parts List
38-10003-01

ITEM	PART NUMBER	DESCRIPTION
1	20-10256-01	Chassis, Display
2	20-10260-01	High Voltage Cage (2105A)
3	20-10261-01	Tube Mounting Bracket, L.H. (2169)
4	20-10262-01	Tube Mounting Bracket, R.H. (2170)
5	22-10233-01	Lable, 'Do Not Operate Warning' (2134)
6	22-10251-01	Lable, 'High Voltage' (2136)
7	22-10252-01	Lable, 'Factory Adjustment Only' (2137)
8	25-10187-01	Nut, Hex #6-32
9	25-10203-01	Screw, Sheet Metal #6 × 3/8 Hex, Type B
10	25-10206-01	Screw, Sheet Metal #10 × ½ Hex, Type A
11	25-10209-01	Lockwasher, Internal #6
12	25-10263-01	Washer, Flat #10
13	25-10264-01	Washer, Fender 3/16 Medium Wide, 1 IN. O.D.
14	25-10265-01	Spring, Century Spring #171C
15	25-10341-01	Washer, Flat #6 3/8" O.D. Waldom #MW-402
16	25-10343-01	Screw, Machine, 6-32 × 3/8, PH PH
17	38-10006-01	Heatsink Assembly - Front
18	38-10006-02	Heatsink Assembly - Rear
19	38-10007-01	Display Board Assembly
20	38-10344-01	Yoke Assembly
21	90-10266-01	Lube, Cathode Ray 19" 19-VARP4

Audio PCB Assembly
Parts List
30-10554-01 Rev. 4

1.	09-10337-01	xxx heat sink compound, Wakefield #120
2	20-10165-01	HSK heat sink 6072B
3.	35-10498-01	pin, male, PC, Molex 02-09-2134
4.	35-10499-01	pin, female, PC, Molex 02-09-1134
5.	35-10557-01	pin, male, PC, Molex 02-06-8013 .062
6.	35-10558-01	pin, female, PC, Molex 02-06-7103 .062
7.	41-10162-01	con, 16 pin, 3M #3408-2202
8.	41-10228-01	con, Molex 03-09-1063, 6 pin recept
9.	41-10496-01	con, Molex 03-09-2092, 9 pin plug
10.	41-10562-01	con, Molex 03-06-1242, 24 pin recept .062
11.	44-10123-01	IC, 74LS04
12.	44-10124-01	IC, 74LS08
13.	44-10128-01	IC, 74LS75
14.	44-10130-01	IC, 74LS86
15.	44-10131-01	IC, 74LS107
16.	44-10134-01	IC, 74LS163
17.	44-10135-01	IC, 74LS164
18.	44-10140-01	IC, 74LS393
19.	44-10146-01	IC, 7815
20.	44-10148-01	IC, 7915
21.	44-10152-01	IC, TL081
22.	44-10551-01	IC, NE555P
23.	51-10104-01	Pot, 10K Bourne 3355P1
24.	53-10055-01	Res, CC, 1/4W, 5% 150 OHM
25.	53-10058-01	Res, CC, 1/4W, 5% 330 OHM
26.	53-10061-01	Res, CC, 1/4W, 5% 820 OHM
27.	53-10062-01	Res, CC, 1/4W, 5% 1 K
28.	52-10064-01	Res, CC, 1/4W, 5% 2.2 K
29.	53-10066-01	Res, CC 1/4W, 5% 4.7K
30.	53-10068-01	Res, CC 1/4W, 5% 6.8 K
31.	53-10069-01	Res, CC, 1/4W, 5% 8.2 K
32.	53-10070-01	Res, CC, 1/4W, 5% 10K
33.	53-10071-01	Res, CC, 1/4W, 5% 18K
34.	53-10073-01	Res, CC, 1/4W, 5% 30K
35.	53-10075-01	Res, CC, 1/4W, 5% 47K
36.	53-10076-01	Res, CC, 1/4W, 5% 68K
37.	53-10089-01	Res, CC, 1W, 5% 2.7 OHM
38.	63-10029-01	Cap, 50V, 50MF SPRAGUE TE 1307
39.	63-10034-01	Cap, Tant, Dip, 35V, 4.7MF
40.	63-10037-01	Cap, Disc, 100V .002MF

Audio PCB Assembly
Parts List
38-10554-01

ITEM	PART NUMBER	DESCRIPTION
41.	63-10038-01	Cap, Disc, 50V, .01MF
42.	63-10040-01	Cap, Disc, 50V, .02MF
43.	63-10041-01	Cap, Disc, 100V, .1MF
44.	63-10050-01	Cap, 100V, .1MF Plessy
45.	63-10553-01	Cap, 1000V, .001MF Plessy
46.	65-10026-01	DIODE, SI, Signal 1N914B
47.	66-10011-01	transistor, NPN 2N3904
48.	66-10012-01	transistor, NPN 2N6292
49.	66-10022-01	transistor, PNP 2N6107
50.	80-10529-01	Audio Board, Speed Freak
51.	87-10552-01	asy ribbon cable, 26 pin, 3''

Steering Coder PCB Assembly
Parts List
38-10544-01 Rev. 1

ITEM	PART NUMBER	DESCRIPTION
1.	35-10557-0	Pin, male, PC, Molex 02-06-8103 .062
2.	35-10558-01	Pin, female, PC, Molex
3.	37-10543-01	switch optical limit (Monsanto #MC+81)
4	41-10563-01	Con, Molex 03-06-2092, 9 pin plug .062
5.	44-10541-01	IC 74LS14
6.	44-10542-01	IC 74LS175
7.	53-10055-01	Res, CC, 1/4W, 5% 150 OHM
8.	53-10062-01	Res, CC, 1/4W, 5% 1 K
9.	53-10070-01	Res, CC, 1/4W, 5% 10 K
10.	53-10075-01	Res, CC, 1/4W, 5% 47 K
11.	63-10034-01	Cap, Tant, dip, 35V, 4.7MF
12.	63-10040-01	Cap, Disc 50V, .02MF
13.	66-10014-01	transistor, NPN 2N5210
14.	80-10545-01	steering coder board

Shift Sensor PCB Assembly
parts List
38-10546-01 Rev. 1

ITEM	PART NUMBER	DESCRIPTION
1.	35-10557-01	Pin, male, PC, Molex 02-06-8103 .062
2.	35-10558-01	Pin, female, PC, Molex, 02-06-7103 .062
3.	37-10538-01	switch, reed (Hamlin #MDRC4-185)
4.	41-10585-01	Con, Molex 03-06-2055, 5 pin plug .062
5.	80-10547-01	shift sensor board

Control Panel Assembly
Parts List
87-10584-01 Rev. 2

ITEM	PART NUMBER	DESCRIPTION
1.	35-10402-01	terminal, solderless for .2 .205X .032 (18-22) WIR
2.	35-10559-01	Pin, male, Molex 02-06-2103 .062, 18-24
3.	35-10560-01	Pin, female, Molex 02-06-1103 .062 18-24
4.	41-10219-01	Con, Molex 03-09-2038, 3 pin plug
5.	41-10561-01	Con, Molex 03-06-2242, 24 pin plug .062
6.	41-10564-01	Con, Molex 03-06-1092, 9 pin recept .062
7.	41-10586-01	Con, Molex 03-06-1056, 5 pin recept .062

Coin Door Assembly
Parts List
3810008-01

ITEM	PART NUMBER	DESCRIPTION
1.	20-10338-01	Fab coin door
2.	25-10227-01	xxx cable tie, nylon 4 In.
3.	25-10270-02	xxx ock, coin door fort #N5078AR403KD
4.	25-10406-01	wsh #10 flat washer plated zinc
5.	25-10407-01	wsh #10 lock washer plated zinc
6.	25-10411-01	nut hex nut 10-24 plated zinc
7.	25-10437-01	xxx tie mount TM 3525 (PANDUIT)
8.	26-10448-01	xxx coin accecptor, #2608-3000-5 with front plate
9.	87-10342-01	asy harness, coin door

Speaker Assembly
Parts List
38-01422-01 Rev. A

ITEM	PART NUMBER	DESCRIPTION
1	20-10293-01	Fab speaker grill
2	21-10269-02	Fab gasket, speaker 9 1/4''x 9 1/4''
3	21-10420-01	Fab gasket speaker 8'' (round)x 1/4''
4	25-10449-01	xxx pop rivet #AD410ABS
5	25-10450-01	xxx rivet washer flat #SBUP 1/8
6	71-10109-01	xxx speaker Becker 908A237

Coin Meter Assembly
Parts List
38-10008-01

ITEM	PART NUMBER	DESCRIPTION
1	29-10218-01	xxx coin meter E607B-10DC24
2	35-10224-01	pin pin, female, Molex 02-09-1118
3	41-10219-01	con con, Molex 03-09-2038, 3 pin plug
4	65-10027-01	DIO rectifier, 1 amp, 1N4003

COIN DOOR
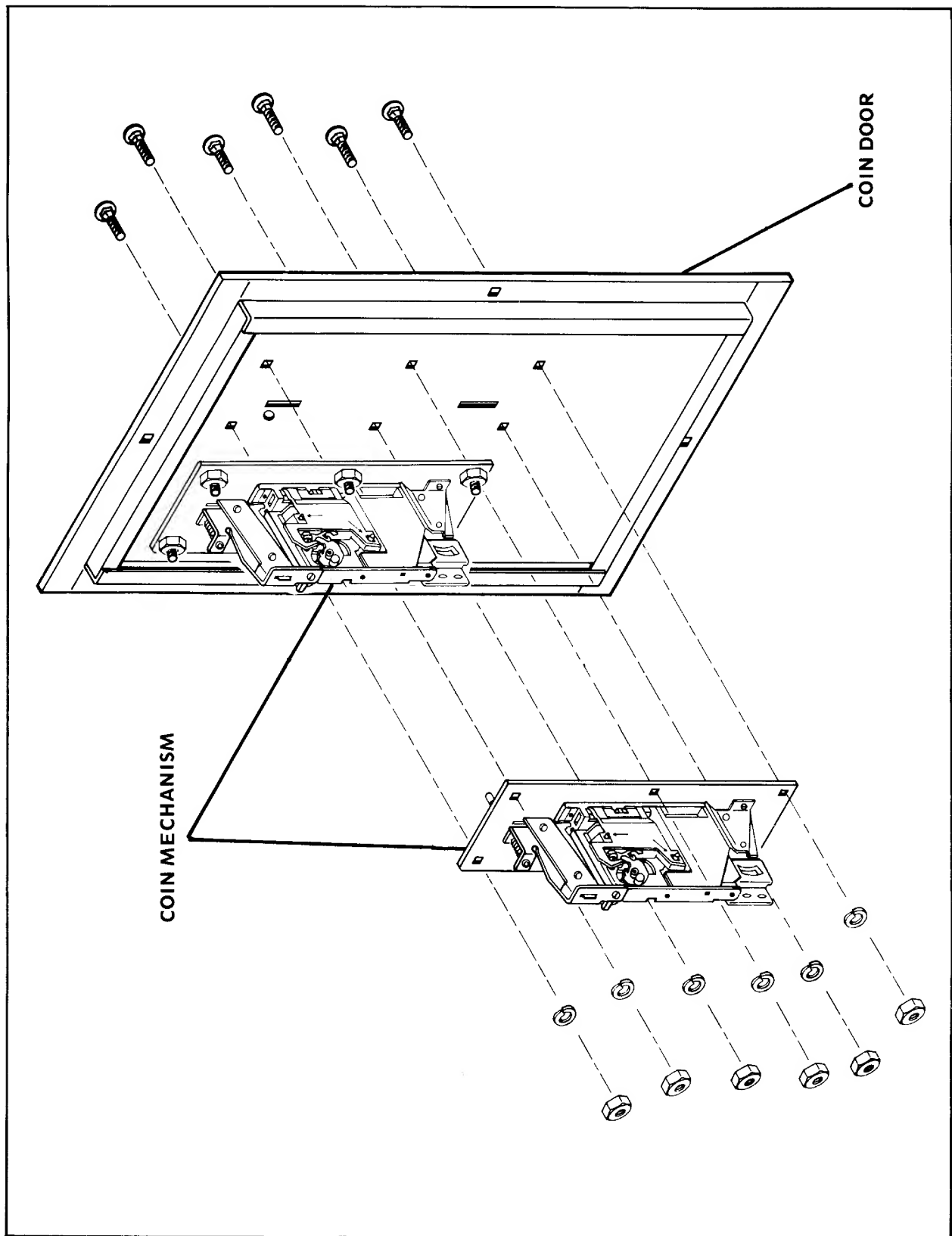
COIN MECHANISM

Figure 5-3 Coin Mechanism Assembly

5-14

Figure 5-4 Power Transistors Wiring

Labels within figure:

TO-3 TRANSISTOR SOCKET, 36-10232
THERMALOY #8113 PF 603
2 PLACES

ALL WIRE 300V 105° C UL LISTED A.W.M.;
STRIP ¼" SOCKET END, ⅛" CONNECTOR END.

TIE WRAP

4¼"

87-10315-01
3 9 2 5 0 6
1 2 3 4 5 6

87-10315-02
5 0 6 3 9 2
1 2 3 4 5 6

CONNECTOR, 41-10228

41-10228
MOLEX #03-09-1063

MALE PIN, 35-10225 MOLEX #02-09-2118
FEMALE PIN, 35-10224 MOLEX #02-09-1118

NOTE:
(2) HARNESS REQUIRED:
(1) 87-10315-09
(1) 87-10315-02; IDENTICAL EXCEPT LOCATION
OF PINS & WIRES IN CONNECTOR

6   WIRE   6½" #18 BLU. 34-10327
0   WIRE   6½", #18 BLK. 34-10326
5   WIRE   6½" #18 GRN. 34-10325
2   WIRE   6½"#18 RED 34-10324
9   WIRE   6½"#18 WH. 34-10323
3   WIRE   6½" #18 ORG. 34-10322

APPENDIX
A

REFERENCE
SCHEMATICS

Figure A-1 Monitor Display Electronics
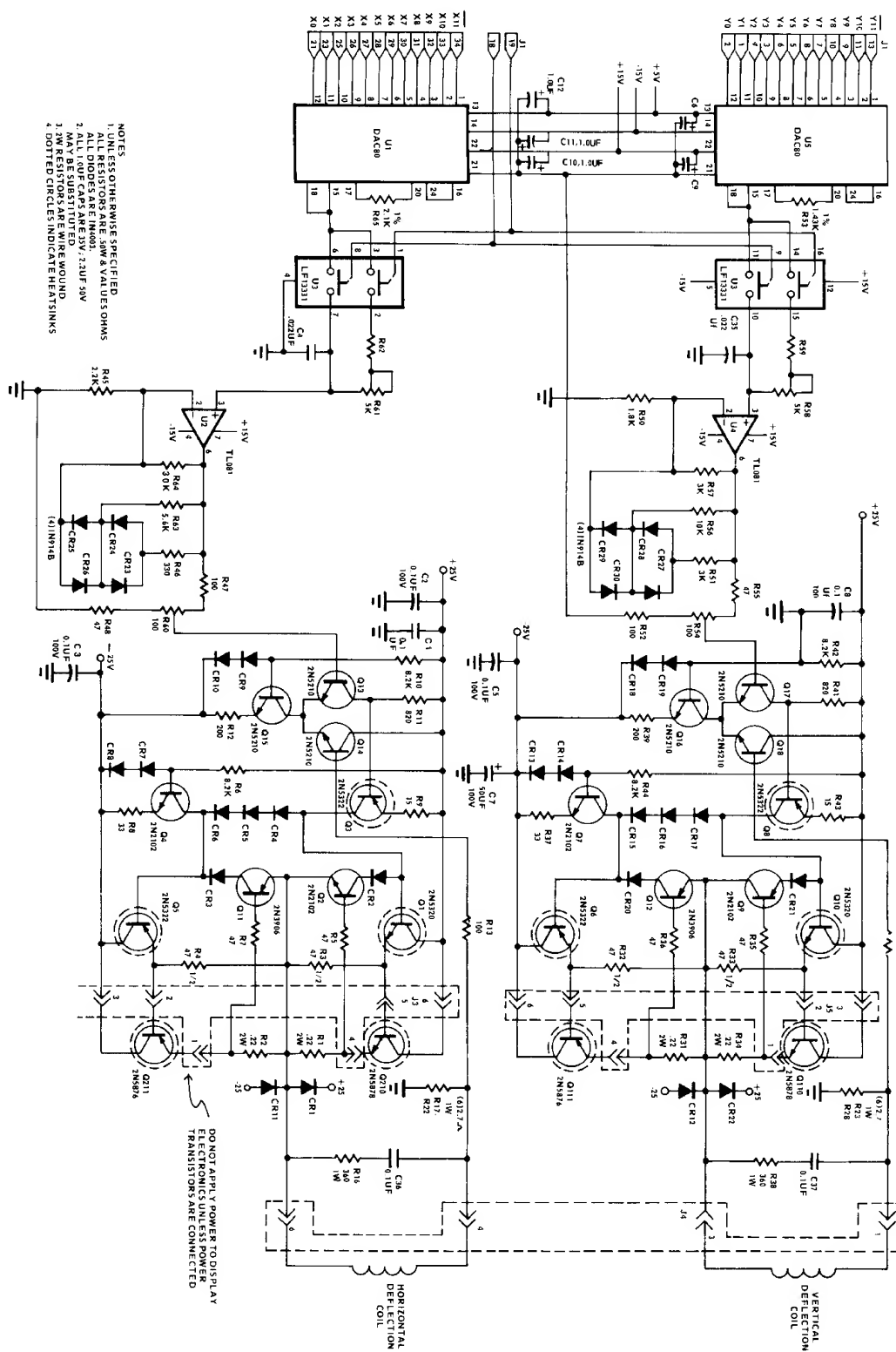
Figure A-2 Vector Display Electronics

A-3

Figure A-3 Input/Output Logic
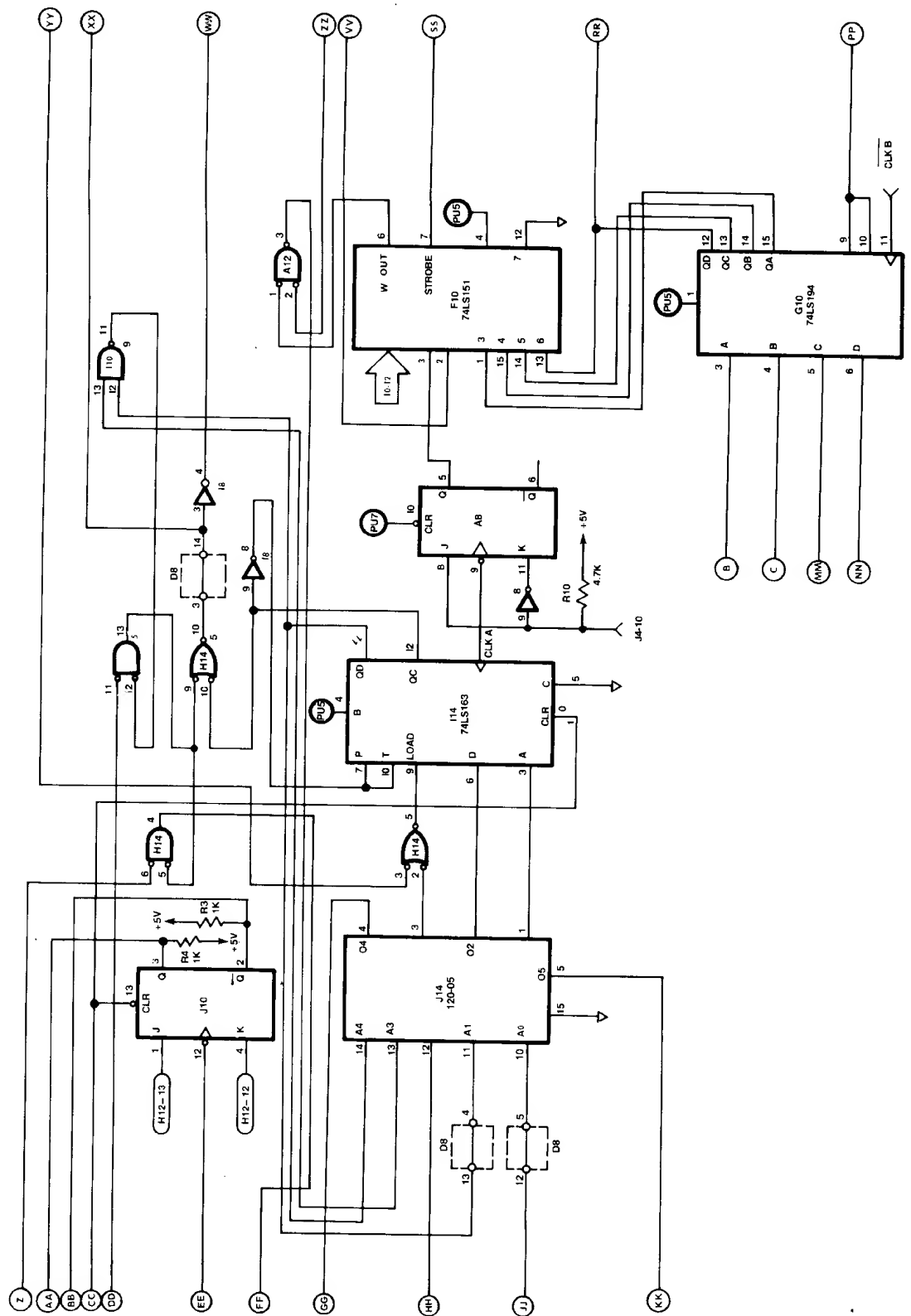
Figure A-4 Sequencer Logic

A-5

Figure A-5 Program Address Counter
Computation Logic
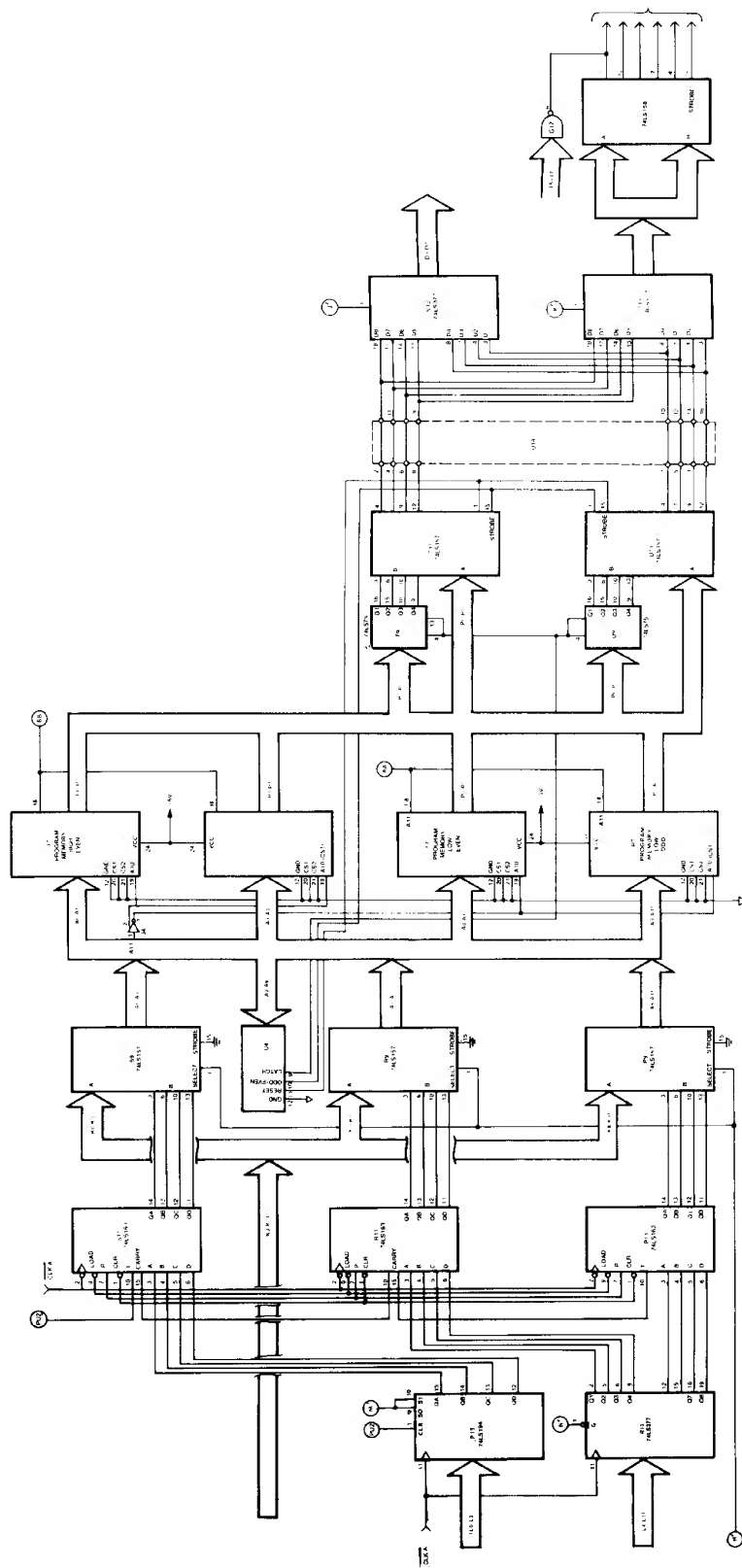
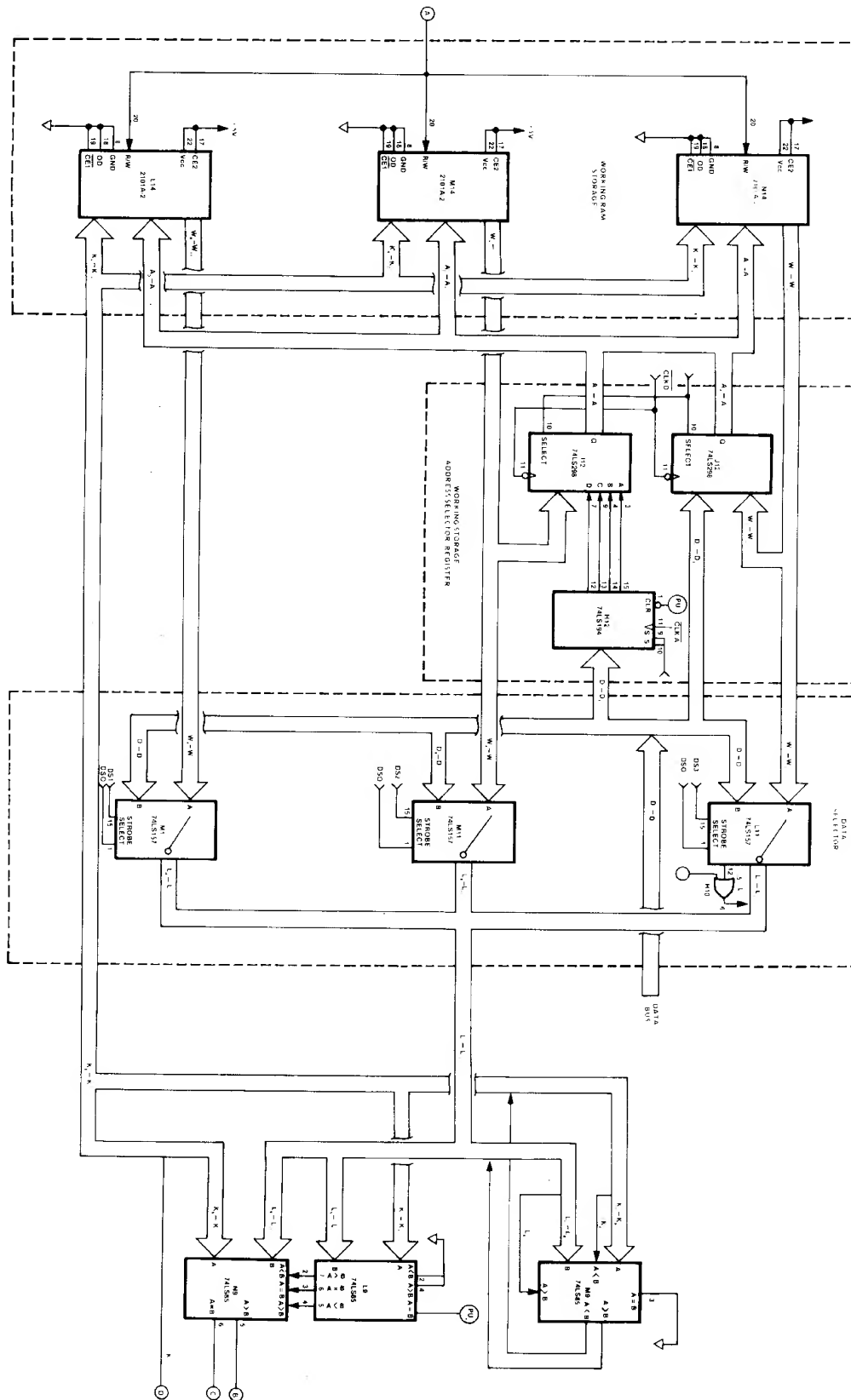Figure A-6 Program Memory, Data Bus Multiplexing
Instruction and Data Register

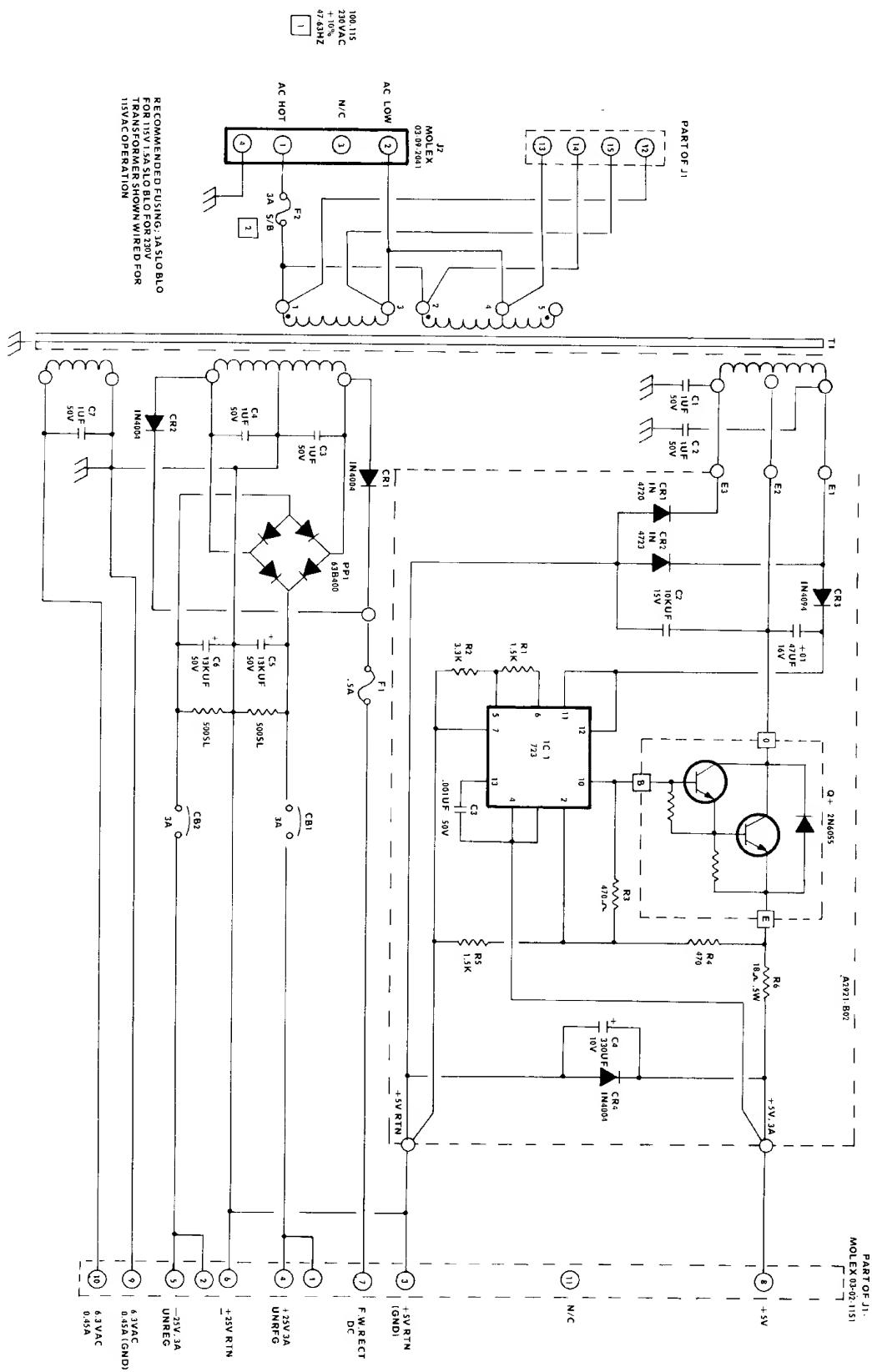Figure A-7 Working Storage, Address Selector
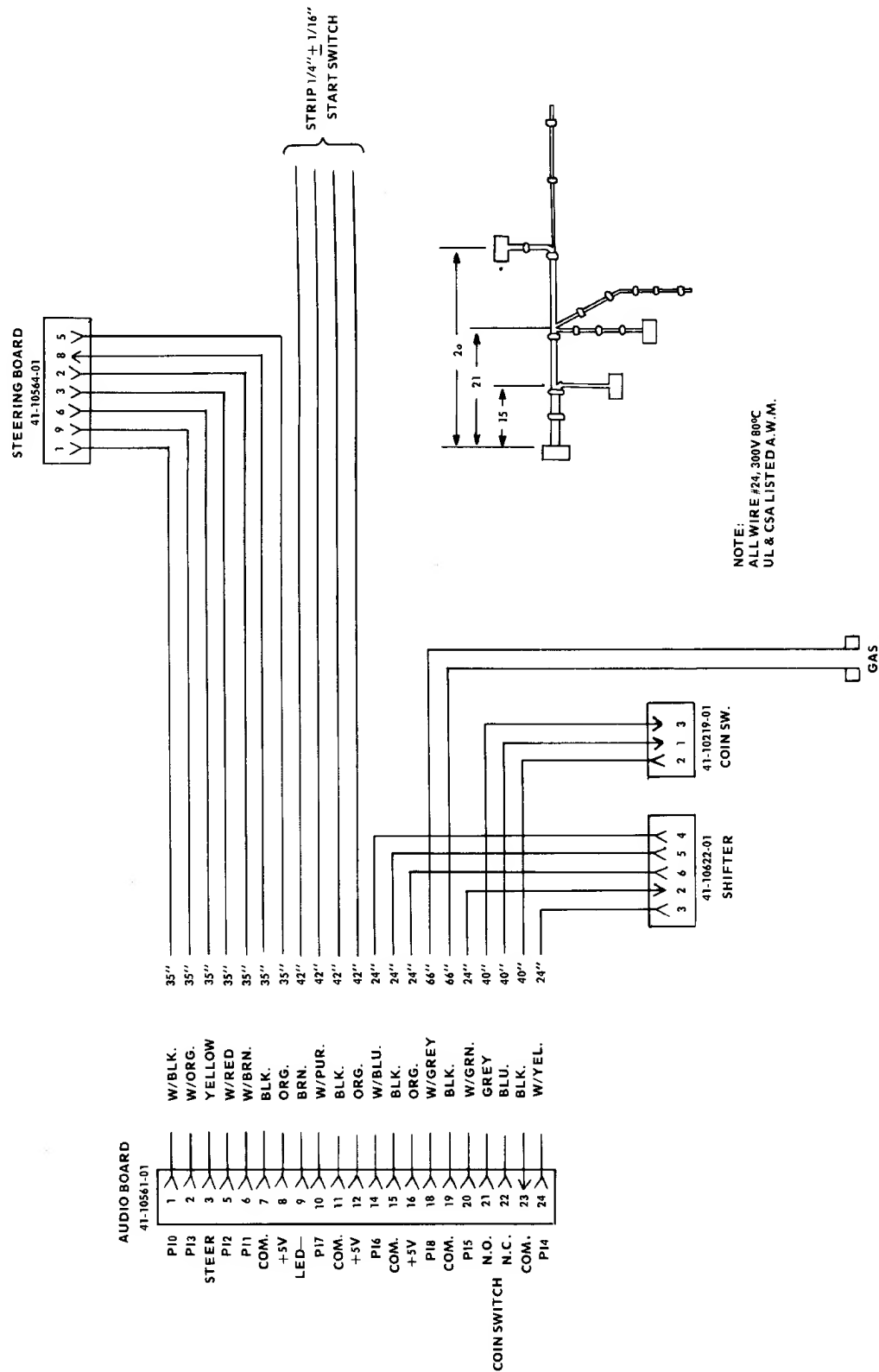Address Selector, and Data Selector

Figure A-8 Oscillator/Clock Logic

A-9

Figure A-9 Power Supply Schematic

Figure A-10 Control Harness
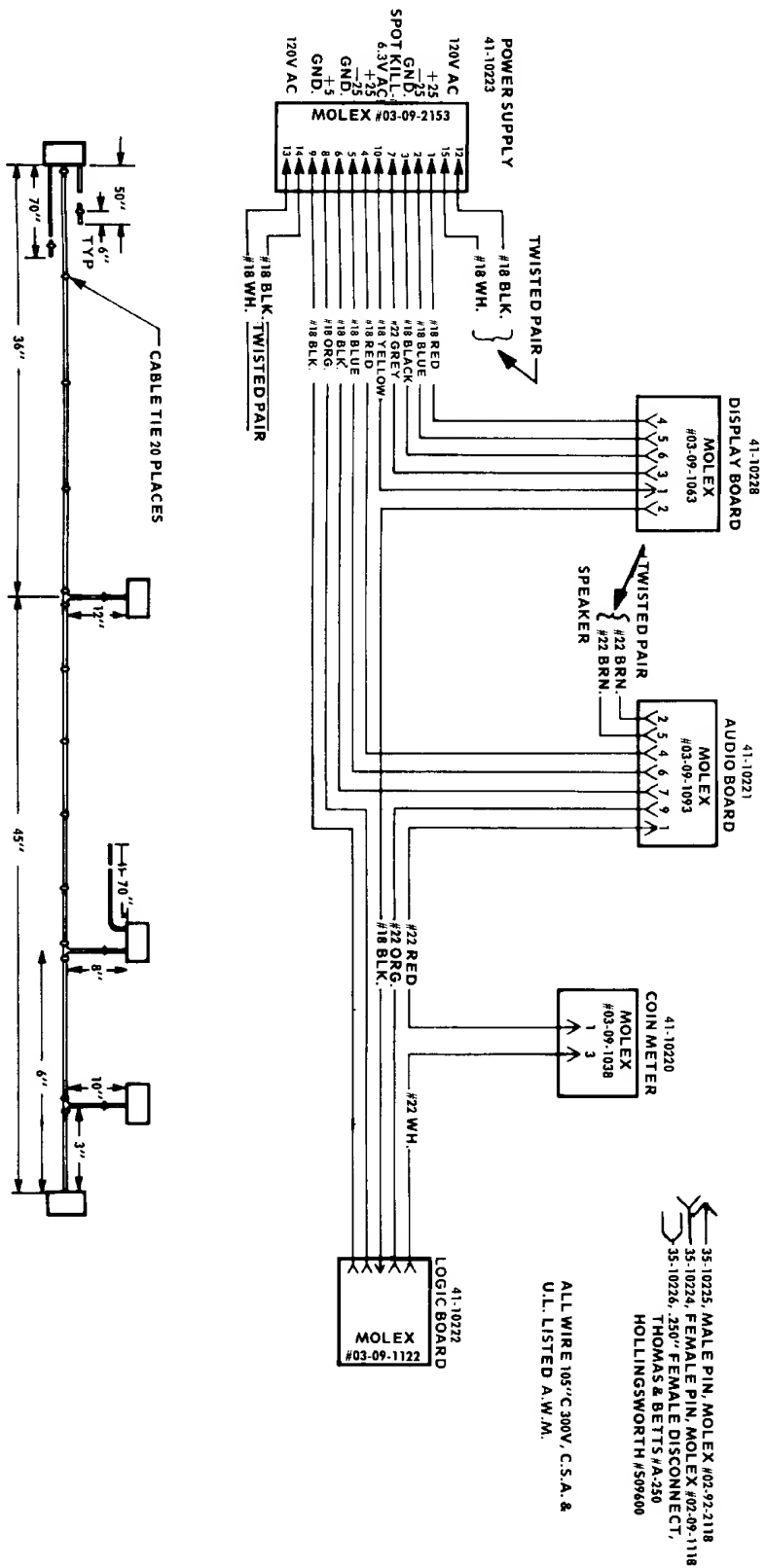
Figure A-11 Power Harness
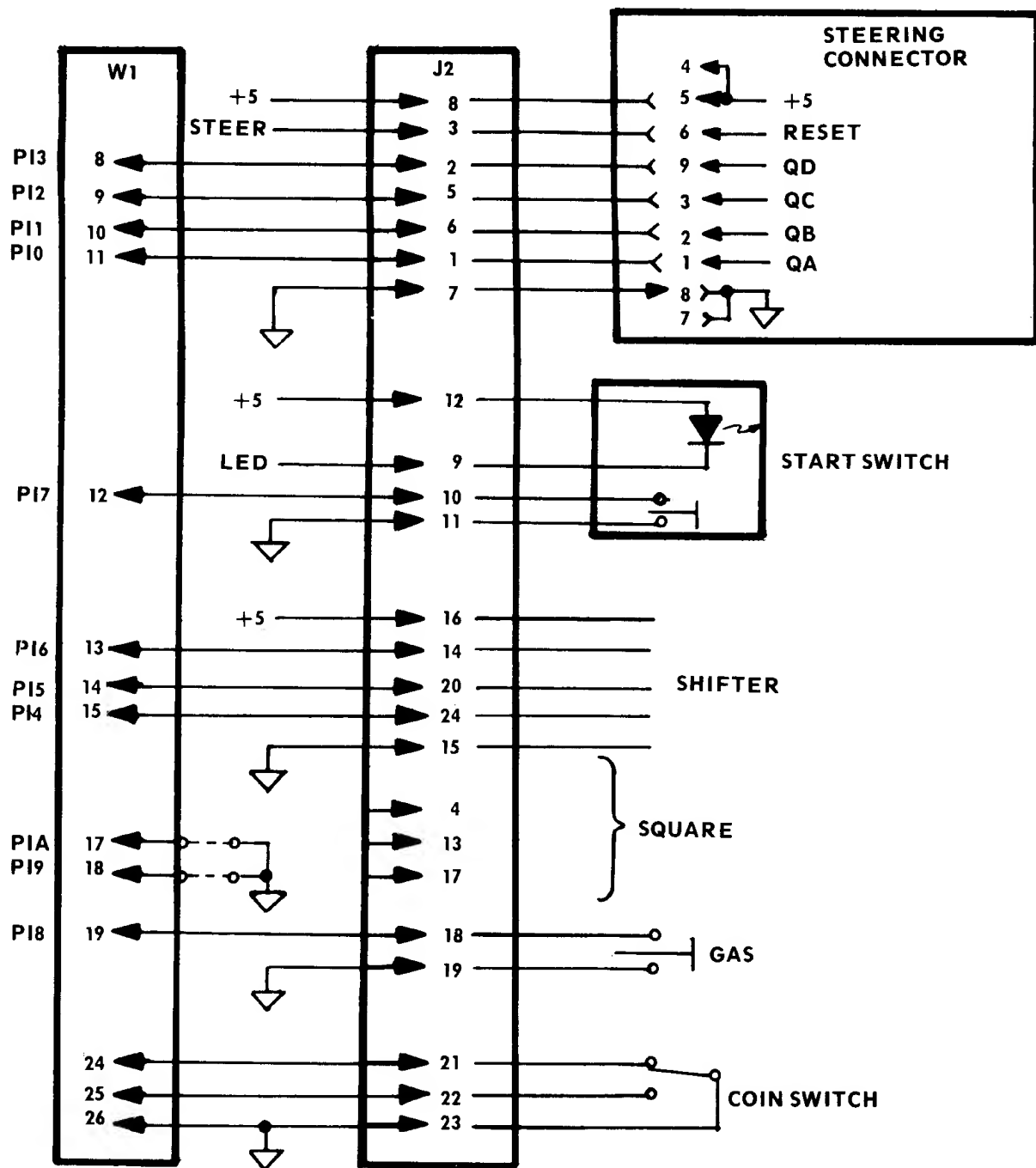
Figure A-12 Audio PCB/Control Panel
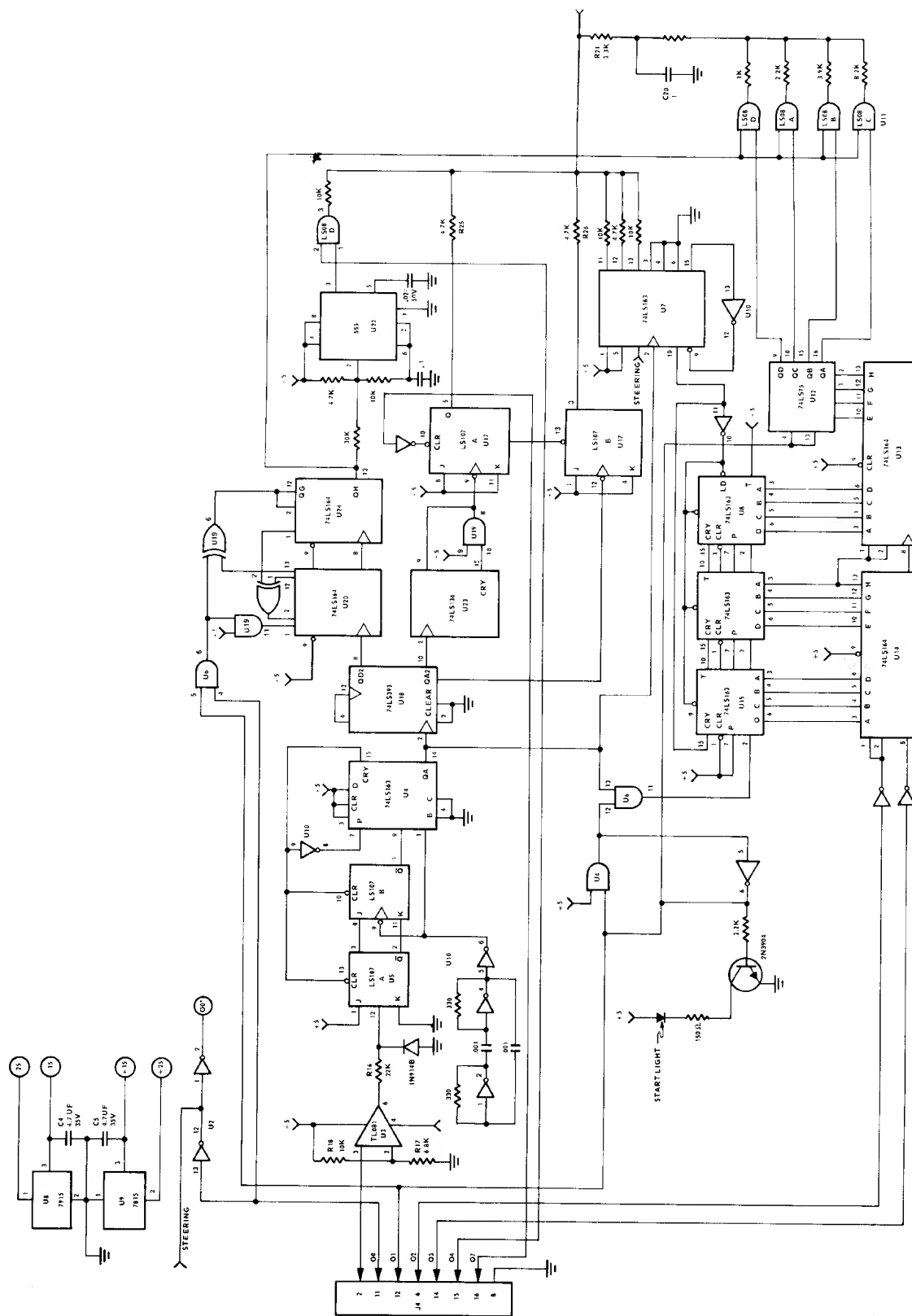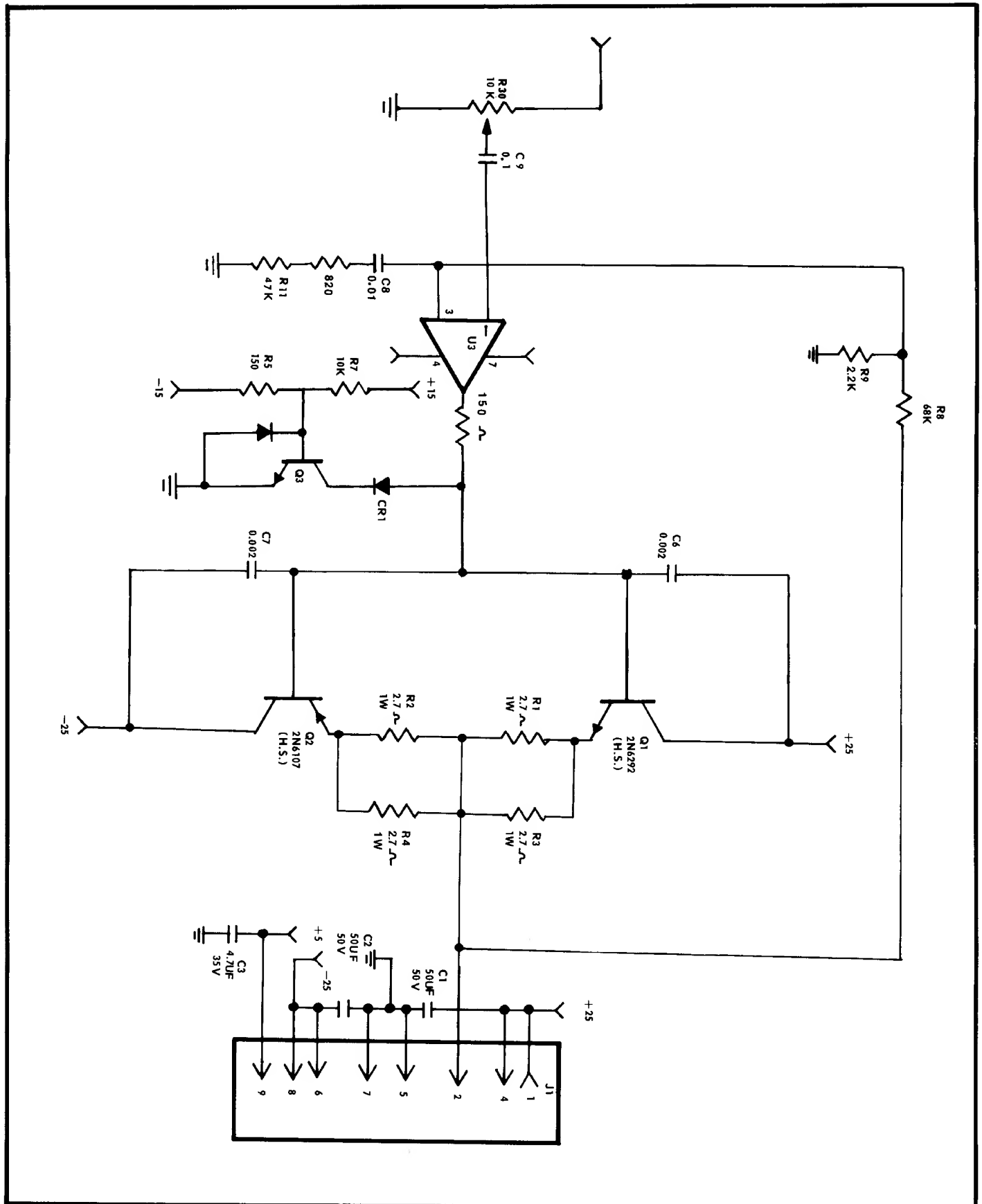Interconnection Diagram

Figure A-13   Steering PCB

Figure A-14 Audio PCB Logic

Figure A-14 Audio PCB Amplifier